104

FUNDING DEPARTMENT OF ENERGY RESEARCH AND DEVELOPMENT IN A CONSTRAINED BUDGET ENVIRONMENT

Y 4.SCI 2:104/77

Funding Department of Energy Resear...

HEARING

BEFORE THE

SUBCOMMITTEE ON ENERGY AND ENVIRONMENT

OF THE

COMMITTEE ON SCIENCE

U.S. HOUSE OF REPRESENTATIVES

ONE HUNDRED FOURTH CONGRESS

SECOND SESSION

AUGUST 1, 1996

[No. 77]

Printed for the use of the Committee on Science

FUNDING DEPARTMENT OF ENERGY RESEARCH AND DEVELOPMENT IN A CONSTRAINED BUDGET ENVIRONMENT

HEARING

BEFORE THE

SUBCOMMITTEE ON ENERGY AND ENVIRONMENT

OF THE

COMMITTEE ON SCIENCE

U.S. HOUSE OF REPRESENTATIVES

ONE HUNDRED FOURTH CONGRESS

SECOND SESSION

AUGUST 1, 1996

[No. 77]

Printed for the use of the Committee on Science

U.S. GOVERNMENT PRINTING OFFICE
37–345 CC WASHINGTON : 1996

For sale by the U.S. Government Printing Office
Superintendent of Documents, Congressional Sales Office, Washington, DC 20402
ISBN 0-16-054948-5

COMMITTEE ON SCIENCE

ROBERT S. WALKER, Pennsylvania, *Chairman*

F. JAMES SENSENBRENNER, Jr., Wisconsin
SHERWOOD L. BOEHLERT, New York
HARRIS W. FAWELL, Illinois
CONSTANCE A. MORELLA, Maryland
CURT WELDON, Pennsylvania
DANA ROHRABACHER, California
STEVEN H. SCHIFF, New Mexico
JOE BARTON, Texas
KEN CALVERT, California
BILL BAKER, California
ROSCOE G. BARTLETT, Maryland
VERNON J. EHLERS, Michigan**
ZACH WAMP, Tennessee
DAVE WELDON, Florida
LINDSEY O. GRAHAM, South Carolina
MATT SALMON, Arizona
THOMAS M. DAVIS, Virginia
STEVE STOCKMAN, Texas
GIL GUTKNECHT, Minnesota
ANDREA H. SEASTRAND, California
TODD TIAHRT, Kansas
STEVE LARGENT, Oklahoma
VAN HILLEARY, Tennessee
BARBARA CUBIN, Wyoming
MARK ADAM FOLEY, Florida
SUE MYRICK, North Carolina

GEORGE E. BROWN, Jr., California RMM*
HAROLD L. VOLKMER, Missouri
RALPH M. HALL, Texas
BART GORDON, Tennessee
JAMES A. TRAFICANT, Jr., Ohio
JOHN S. TANNER, Tennessee
TIM ROEMER, Indiana
ROBERT E. (Bud) CRAMER, Jr., Alabama
JAMES A. BARCIA, Michigan
PAUL McHALE, Pennsylvania
JANE HARMAN, California
EDDIE BERNICE JOHNSON, Texas
DAVID MINGE, Minnesota
JOHN W. OLVER, Massachusetts
ALCEE L. HASTINGS, Florida
LYNN N. RIVERS, Michigan
KAREN McCARTHY, Missouri
MIKE WARD, Kentucky
ZOE LOFGREN, California
LLOYD DOGGETT, Texas
MICHAEL F. DOYLE, Pennsylvania
SHEILA JACKSON LEE, Texas
WILLIAM P. LUTHER, Minnesota

David D. Clement, *Chief of Staff and Chief Counsel*
Barry Beringer, *General Counsel*
Tish Schwartz, *Chief Clerk and Administrator*
Robert E. Palmer, *Democratic Staff Director*

Subcommittee on Energy and Environment

DANA ROHRABACHER, California, *Chairman*

HARRIS W. FAWELL, Illinois
CURT WELDON, Pennsylvania
ROSCOE G. BARTLETT, Maryland
ZACH WAMP, Tennessee
LINDSEY O. GRAHAM, South Carolina
MATT SALMON, Arizona
THOMAS M. DAVIS, Virginia
STEVE LARGENT, Oklahoma
BARBARA CUBIN, Wyoming
MARK ADAM FOLEY, Florida
STEVEN H. SCHIFF, New Mexico
BILL BAKER, California
VERNON J. EHLERS, Michigan
STEVE STOCKMAN, Texas

TIM ROEMER, Indiana
DAVID MINGE, Minnesota
JOHN W. OLVER, Massachusetts
MIKE WARD, Kentucky
MICHAEL F. DOYLE, Pennsylvania
JAMES A. BARCIA, Michigan
PAUL McHALE, Pennsylvania
EDDIE BERNICE JOHNSON, Texas
LYNN N. RIVERS, Michigan
KAREN McCARTHY, Missouri
HAROLD L. VOLKMER, Missouri
SHEILA JACKSON LEE, Texas

---

*Ranking Minority Member
**Vice Chairman

CONTENTS

Page

August 1, 1996:

Panel 1:

Mr. W. Henson Moore, Former Deputy Secretary of Energy and President and CEO, American Forest and Paper Association, Washington, DC 4
Mr. Allen Li, Associate Director, Energy, Resources, and Science Issues, Resources, Community, and Economic Development Division, U.S. General Accounting Office, Washington, DC 12
Mr. Gregory H. Friedman, Deputy Inspector General for Audits, U.S. Department of Energy, Washington, DC 26
Mr. Roger A. Lewis, Senior Advisor, Office of Strategic Computing and Simulation, U.S. Department of Energy, Washington, DC 31

Panel 2:

Dr. Danny L. Hartley, Vice President, Laboratory Development Division, Sandia National Laboratories, Albuquerque, New Mexico 51
Dr. Ronald W. Cochran, Laboratory Executive Officer, University of California, Lawrence Livermore National Laboratory, Livermore, California 58
Dr. Charles F. Gay, Director, National Renewable Energy Laboratory, Golden, Colorado 67

APPENDIX

Additional testimony:

Mr. Richard Wilkey, President, Fisher-Barton, Inc., Watertown, WI 79

Additional material:

U.S. General Accounting Office, "Energy Research: Opportunities Exist to Recover Federal Investment in Technology Development Programs," Report to the Chairman, Subcommittee on Energy and Environment, Committee on Science, House of Representatives, June 26, 1996 (GAO/RCED-96-141) 88
U.S. Department of Energy Office of Inspector General, *Report on "Audit of Energy's Activities Designed to Recover the Taxpayers' Investment in the Clean Coal Technology Program,"* June 6, 1996 (DOE/IG-0391) ... 118

Questions and answers for the record:

Mr. W. Henson Moore 143
Mr. Roger A. Lewis 146
Mr. Allen Li 294
Mr. Gregory H. Friedman 301
Dr. Danny L. Hartley 306
Dr. Ronald W. Cochran 398
Dr. Charles F. Gay 402

FUNDING DEPARTMENT OF ENERGY RESEARCH AND DEVELOPMENT IN A CONSTRAINED BUDGET ENVIRONMENT

THURSDAY, AUGUST 1, 1996

U.S. HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE,
SUBCOMMITTEE ON ENERGY AND ENVIRONMENT,
Washington, DC.

The Subcommittee met at 10:07 a.m. in room 2318 of the Rayburn House Office Building, the Honorable Dana Rohrabacher, Chairman of the Subcommittee, presiding.

Mr. ROHRABACHER. This hearing of the Energy and Environment Subcommittee will come to order.

Today we will look at the Department of Energy's efforts to obtain repayment for government-industry partnerships that result in commercialization of technology.

We are faced with two undeniable realities:

One is a shrinking Federal budget;

And the other is a desire by many Members of Congress and the National Laboratories to continue these partnership programs.

The combined funding for technology transfer in the Department of Energy budget for both civilian and defense programs has dropped from $264 million two years ago to $115 million today.

The question is: are there innovative financing solutions that would benefit both the taxpayer-investor and the government-industry partnerships?

The question we must ask ourselves—shouldn't the taxpayers get their money back from a successful profit-making venture?

As we will hear today, the DOE already has entered into numerous financing arrangements for technology partnerships. They include cost-sharing repayment, royalty and licensing agreements. However, the agreements seem to vary widely from program to program and from lab to lab.

Is it now time to ensure—and I would imagine it is—that the taxpayer have some payback that the average investor of the United States is entitled to?

This is not a new concept.

We will hear today from former Deputy Secretary of Energy, Henson Moore, about his efforts to initiate an investor offset agreement designed, at a minimum, to recover the direct investment of funds by the Department of Energy. Unfortunately, Mr. Moore left the Department before his plan went into effect and the program died.

The General Accounting Office will present its report on current DOE cost-sharing and reimbursement programs, and the DOE Inspector General will present its audit of perhaps the granddaddy of all cost-sharing efforts, the Clean Coal Program. And let me say, I especially appreciate the General Accounting Office who have done a terrific job for us in a number of areas, and am looking forward to their testimony as well.

This program has had some strong payback provisions which got mysteriously watered-down along the way—and I am still talking about the Clean Coal Program.

We will also get to the DOE's response to these reports.

Later we will get the views of three National Laboratories who are actively pursuing government-industry partnerships.

This is a fact-finding hearing. I will have to say that I am interested in this, but I really do not have a lot of preconceived ideas or commitments as to what direction to go, but we know the goal we are looking at, and I think we can all work together and learn in this hearing to find out how to get to that goal.

Of course, my goal is to use the information from today's hearing to develop a bipartisan proposal that would have a positive effect on technology advancement as well as a positive impact on the taxpayer's wallet.

I believe there is support for this idea on both sides of the aisle, and I hope we can gain agency support, as well.

You know, a lot of us believe that the private sector inherently is seeking to make a profit and do things more efficiently than the government. When we get the government and the private-sector together, it is important for us to try to find ways of making a more profitable arrangement between the two.

I heard a story that I will share with you before turning to Mr. Roemer about some fellows in the private sector who thought that they were going to combine their efforts in a way that would be mutually beneficial.

One was a taxidermist, and the other was a veterinarian.

They figured if they got together, they could combine a lot of their costs. They could actually have the same building, and the same offices, and the same computers and they would basically be able to offset some of the costs in that way.

Well, they did get together and they formed a business partnership, this taxidermist and the veterinarian. Their motto was put over their building door, and it said:

One way or the other, you're going to get your dog back.

[Laughter.]

Mr. ROHRABACHER. I thought that was a good one, anyway.

Mr. ROEMER. Do we have to share bipartisan laughter?

[Laughter.]

Mr. ROHRABACHER. You got a better one than I did. Okay. I now turn to our Ranking Member, Mr. Roemer, for any opening remarks that he would like to share with us.

Mr. ROEMER. Thank you, Mr. Chairman.

While I am not sure I endorse the joke, I certainly endorse the concept and look forward to working with you on this idea, which I think is a very good one.

When the taxpayer invests in an R&D project, I think that the taxpayer has every right to recoup some of that initial investment. I think that there should be more joint partnerships and there should be more innovation between the private sector and the United States Government.

I would ask unanimous consent, Mr. Chairman, that my entire statement be entered into the record.

Mr. ROHRABACHER. Without objection.

Mr. ROEMER. I would say, as a compliment to your work that maybe matches your sense of humor, that you and I work well together on this Subcommittee. You and I have worked together on a host of different amendments on the Floor, and bills in this Committee, and this is yet another area where there is a great deal of agreement between your philosophy and my approach to this legislation.

I look forward to working with you through the rest of this Congress and into the next Congress, should our voters send us back here, to do these kinds of common-sense legislation.

With that, again I want to welcome the distinguished panelists here. I look forward to hearing many of the people that we have had up here before to testify, and to a former colleague, Henson Moore, from the State of Louisiana, who has served in Congress with my father-in-law, as well, too. It is a pleasure to have you here.

Mr. ROHRABACHER. By the way, just a note.

There was a bill put forward, or I guess it was an amendment, that would say that if a pharmaceutical company receives money, or receives benefit through government research, whether it is government research money directly or basically whether it is just the benefit of government research, if a pharmaceutical company has that as an asset when it is developing a new drug, that the government would be able to put a lid on the price of what they would be able to charge for that drug.

I want to note for Mr. Roemer that I was one of the only four Republicans that voted for that particular amendment that Bernie Sanders put forward the first time.

The second time we had 30 Republicans who voted for it. I believe that this concept of, if you are going to receive a benefit from the taxpayers that you are going to owe something in return to the taxpayers. I think this is a principle that eventually, if we really look at it honestly and get together, this is something all of us can agree on because it is certainly within the philosophy of both of our parties to do this. And, it is what is fair to the taxpayers.

So with that, I would like to start with our first witness, Mr. Moore, and then we will go right down the line. I am going to introduce Mr. Moore, who has already been introduced.

First of all, we have Henson Moore. He is currently president and CEO of American Forest and Paper Association, but from 1989 to 1992 he served as Deputy Secretary of Energy and devoted considerable time to the issue before this hearing, as I stated in my opening remarks.

Before that, of course, Mr. Moore served as a distinguished Member of this House.

Allen Li is the Associate Director for Energy, Resources, and Science Issues at the General Accounting Office. We have worked with Mr. Li on many occasions, as I said in my opening remarks.

Mr. Gregory Friedman is Deputy Inspector General for Audits at the Department of Energy.

And Mr. Roger Lewis is currently Senior Advisor in the Office of Strategic Computing and Simulation at the Department of Energy. He earlier served as Director of the DOE's Technology Partnerships and Economic Competitiveness Office.

So I want to welcome all of those witnesses, and, Mr. Moore, would you like to proceed?

STATEMENT OF HENSON MOORE, FORMER DEPUTY SECRETARY OF ENERGY, PRESIDENT AND CEO, AMERICAN FOREST AND PAPER ASSOCIATION

Mr. MOORE. Thank you, Mr. Chairman.

I would like to submit the written testimony for the record and do something that used to cause great tremors in my friends from the Department of Energy by departing from prepared text and just sort of winging it.

So I would like to do that at this point and give you just some thoughts and memories I have of having worked this issue, understanding, I think, where you are coming from, from a policy point of view.

Let me also say, I am not saying anything in criticism of this present Department of Energy or the past one. I happen to have great respect for that Department and the people that work there, and the mission they undertake.

I consider the friendships I made there existing to this day.

But let me tell you a little bit about this story:

When you embark on the idea of cost-sharing, it has been around for a while, but I think largely lip service was paid to it in terms of, are you really serious about getting the taxpayers' money back.

When you go a step further, as I did, in terms certainly of trying to put teeth into getting the money back, but when you go a step further and decide that you want to get recoupment of the government portion, and maybe even a profit on that, then you have really gone out into "Never-Never Land" and you are out there all by yourself, and that is where I was for three years in the fact that nobody in the Congress understood it——

Mr. ROHRABACHER. That was "premature enlightenment."

[Laughter.]

Mr. MOORE. So I want to let you know what you are getting into. You are going to find nobody that supports it. Everybody is going to give lip-service support to cost-sharing.

Nobody is going to support, or very few are going to support recoupment. And then recoupment beyond the government's investment you will find, if there is anybody who supports you for recoupment, that is where the train stops and they will not support you at that step.

I wanted the whole McGillicuddy; to go the whole way. I did not believe, and we did not believe, in that Administration at DOE, in corporate welfare.

How the whole thing came to my attention is, as I indicated in the testimony, the daily reporting in the Department included all the non-defense functions of the Department.

That included all the DOE research work. One day I was asked to sign off on the sale of a license for a fuel cell to a Japanese company. I kind of looked at that, and it was rather routine. The amount of the sale was minuscule. The amount of money, it was almost nothing; and I found, not to the criticism of this company or the Japanese government, but they were the greatest patrons of our laboratories.

American companies seldom set foot in one of our daily laboratories, which I think are some of the finest in the country—the finest in the world—but the Japanese were in every laboratory every month.

If you look at the visitors' logs, you will see that. Because they appreciated research, knew what was coming down the pike, and knew it was free. They knew you could just walk in and ask for it, and basically get it.

So that kind of disturbed me. We went to work on trying to put some teeth into it and stop the train in the tracks at that point and said, no, we are not going to just give lip service to cost recoupment.

If they want to buy this technology, they are going to pay for it. We also ultimately convinced them to build, I believe, a factory in California to manufacture the fuel cells, as opposed to taking the technology back to Japan.

All of this was highly irregular. All of this, with not much in the way of any regulatory support, or any kind of support in the law for doing this other than roughly cost recoupment, or rather cost sharing which this was already done, so we were granting a license—an exclusive license at that—which the Department of Energy did from time to time, but the Department of Energy, to its defense, is not a business. It does not think like a business.

It thinks like a public service organization.

Look what we have done in our laboratories; isn't it great?

Now how do we get this out to serve mankind?

That is how they think. They do not think in terms of, "Wait a minute. We have put money into this. How do we get money back? How do we sell this in a way that creates American jobs?" On down the line. That is just not the way people think in the government laboratories, at least in the time frame that I worked with them, and they basically directly reported to my office.

So we decided to get tough on the idea of cost-sharing. In the rounds of the Clean Coal technology that came out, we put in much tougher cost sharing, or getting our costs back, than the law required.

I ran into an immediate buzz saw.

First there was resistance within the Department of Energy. As I said, they are a government entity, not a business. The whole idea was—how do we know how to do this? We do not know how to do this. We do not have any experience on this. We do not have regulations on this.

They had all the reasons why it could not be done, and all the reasons were true. We were going out into uncharted waters, to a great extent. But we pressed forward and pushed ahead.

Then we ran into resistance, obviously, from the recipients of the Clean Coal Technology grants. This money was meant to be basically free. What are you doing messing with us and trying to make us pay it back? We are not very serious about paying it back.

And I don't know, the GAO can testify to this, I don't know if a dime was ever recovered before we got tough starting in about 1989 or 1990 in trying to get that money back.

And then thirdly I ran into a buzz saw from the Congress——

Mr. ROHRABACHER. Could you tell us how you wanted to get the money back? How did that work?

Mr. MOORE. Basically, back then—and the details get a little fuzzy with me, but there are people in the Department who know this story, both in the General Counsel's office and in the Office of the Clean Coal Technology Program, based on the experience we had with the fuel cell, I began to question every single thing that came across my desk from the point of view of, "What are we doing to try to get the taxpayers' money back?"

I found that there was just a very loose, soft, program departmentwide with anything we were doing. Very seldom—about the only time you saw anybody talking about cost-sharing was in the Clean Coal Technology Program which the law said they ought to do. And, that every now and then if we were going to grant an exclusive license on something we had invented and was on the shelf.

Other than that, you did not hear talk about it. This was pre-CRADA days. The CRADAs came right along in the wake of this as part of our technology transfer program.

So when I entered the water, not knowing what the heck I was doing, and waded into this, I soon learned that there just really wasn't anything really going on in terms of cost-sharing, and nothing at all going on in terms of cost-recoupment. It just did not exist.

As I said, it was just the way government operated. Government was not thought to be a business.

The people who wanted the money from the Federal Government obviously would prefer not to pay it back. And so they found all kinds of reasons not to do it.

The inertia of the bureaucracy in the Department of Energy found all kinds of reasons not to do it because you had to put your neck on the line. You had to draw up a contract, or you had to write regulations. And for everything we did, we used to get letters from the Hill asking us to come down here and explain it.

So it was a whole lot easier not to do it than to stick your neck out and to get off into something that was not very clear and was not very established.

Then we found that Congress objected. I had calls from staff on the Appropriations Committee raising holy heck with me over the very idea of tightening up the idea of cost-sharing on the Clean Coal Technology Program.

I was slowing the program down. I was going to keep people from getting involved in the program. I was in fact messing up the whole purpose of the program.

We stood our ground and said, no, if this stuff is really good, people will pay their share and will get involved in this.

Then we began to try to put into it cost recoupment—go one step further and say, okay, you are going to share in the cost of this, but the taxpayer, if this is a successful technology, and if it is applied commercially, and if you have the rights exclusively to use it, and after you have gotten all your money back, we want ours back.

That was a novel thought. That was a thought, again, that upset the apple cart within the Agency, within the Congress, and within the community that worked with us on these projects.

I got more and more—it was like a tar baby. Once you grab hold of this thing, you could not get loose of it. You know, you had to stick with it.

So we convened a meeting of business people, and we began the CRADA program in technology transfer and found out that the business people really were suspicious of the government, really did not want to do business with the government on tech transfer, and really thought the government was just highly bureaucratized and it was too complicated and they did not want to fool with it.

We learned that if you were ever going to transfer technology out of our laboratories to create American jobs, you had to streamline the process, which we did, and this Administration is continuing that, to its credit, and we had to also begin to act in a more businesslike fashion.

Businessmen understood cost recoupment. They understood a partnership and sharing and licensing. They might try to negotiate you down so you would not have to—they would not have to give, but they understood that.

We found that if you got them involved very early on a project where they were helping direct that project, they were far more likely to sign on the dotted line. They were far more likely to agree to cost-sharing.

The Battery Consortium is a good example of that. That was done on our watch to create the ultimate battery for an electric car. They understood the need for that.

They understood we are all going to do it together, and they were willing to sign on the dotted line to come up with a cost for that.

So basically I guess we moved from what was a system that was there and not much being done with it, to trying to put some teeth into it, to realizing that our laboratories, if they were going to survive as we moved out of the defense role and specter, they had to do more in tech transfer to earn their keep.

They had to get the technology out of the laboratories and into the hands of American industry. To do that, businesses were not coming and buying technology off the shelf from us. That is where the CRADAs became born, the Cooperative Research Agreements.

It was a good idea—a good idea to this date. But if you do not believe in corporate welfare, and you do not believe in a government industrialization program—and I did not, and we did not back then—this has to be on a business basis. Okay, we will use our laboratories to help the economy, but you are going to pay for it.

Furthermore, you really ought to pay recoupment. You ought to really pay us back the part the government put in with a profit after a certain time period.

Ultimately, we finally, in the Energy and Policy Act of 1992, we did get cost-sharing put into legislation for supposedly anything the Department of Energy does.

We did not get recoupment in there. We only got the cost-sharing part in. The cost-sharing part, we got what we got in there, but we also got, probably in hindsight, too much in the waiver, and to much in the way of waiver authority in there, to where you really could pretty well—the Congress said in one line, "Recoup the cost," and in the next line said: "However, you know, for any reason almost under the sun, you can waive that necessity of doing that." There again you go back to the prevailing mood of the Department, and obviously the people who want this, which is not to pay.

So it is very easy to fall back into. Let's do not go through all the hassle, and all the trouble in trying to have a repayment schedule here of any kind, or a payment agreement of any kind.

[The prepared statement of Mr. Moore follows:]

TESTIMONY OF: W. HENSON MOORE

FORMER DEPUTY SECRETARY OF ENERGY

BEFORE THE SUBCOMMITTEE ON ENERGY AND ENVIRONMENT

COMMITTEE ON SCIENCE

U.S. HOUSE OF REPRESENTATIVES

ON CO-FINANCING OF FEDERAL R&D AND FEDERAL INVESTMENT RECOUPMENT POLICY

AUGUST 1, 1996

SUMMARY

Mr. Chairman and members of the Subcommittee, I appreciate the invitation to testify on a subject that preoccupied me repeatedly during my tenure as Deputy Secretary of Energy. I believed then as I do now that the value of Federal investments in technology research and development is maximized when agencies are made to insist on strong financial partnerships with non federal participants. There is no contradiction, as some would have us believe, between the pursuit of Federal R&D that benefits society and the pursuit of maximum feasible non-Federal support for such investment. Indeed, the evidence points conclusively to the view that the greater the degree of non-Federal support for taxpayer financed R&D programs, the higher the likelihood of economic and commercial success for the technology in question.

For that reason, I would recommend revisions to the provisions of the Energy Policy Act that address R&D co-financing and investment recoupment requirements, with a view to reducing Federal agencies' discretion in waiving such requirements.

BACKGROUND

Let me hasten to confirm that I am the Deputy Secretary of Energy cited in the June 1996 GAO report[1] on recovery of Federal investment in R&D. As reported, I attempted to institutionalize, by secretarial order, the concept that taxpayer investments in the development of new technology must be considered as valuable as those made by the private sector firms. If public investments in R&D are as important as we claim they are in the budget preparation, authorization and appropriation process, then there should be no hesitation about seeking a practical financial return on what amounts to public participation in the nation's economy.

---

[1] GAO: Report to the Chairman, Subcommittee on Energy and Environment, Committee on Science, House of Representatives: ENERGY RESEARCH: Opportunities Exist to Recover Federal Investment in Technology Development Projects.

My insistence on obtaining value for the results of research conducted at Department of Energy (DOE) laboratories and technology demonstration centers was fostered by a specific case that came to my attention fortuitously. It was a request by DOE's office of Fossil Energy for approval to transfer to a private foreign firm a license to manufacture state-of-the-art fuel cell technology developed at one of DOE's laboratories. I objected to the nominal—insignificant, really—payment requested by DOE for the license, and directed that a more business-like arrangement be negotiated that would show evidence of the proper value of what appeared to me to represent very innovative, and potentially highly profitable technology.

We were then, you may recall, as we are once again in an intensive debate about global climate change, and about the range of possible interventions that would be required to stabilize or reduce emissions of greenhouse gases. And we were dealing with the commercialization of a technology—natural gas powered fuel cells—developed entirely by a Federal research institution, that had the potential to cost effectively generate electricity with minimal emissions of SOx, NOx, and C02. We were practically giving the technology away. We were giving it away, incidentally, to a foreign firm which, to its credit, recognized the long term value of the technology, and sought it more insistently and single-mindedly than any U.S. counterpart firm.

The case-specific negotiations on the fuel cells technology licensing were subsequently concluded to my general satisfaction. But it seemed to me that for every case that made its way up the chain of command to the Deputy Secretary's office, there were probably a dozen other cases that received routine bureaucratic attention, with likely not very satisfactory financial results for the taxpayer.

My further investigation of the broader issue of taxpayer return on R&D investment exposed what I considered a casual treatment of statutory provisions for recoupment of Federal investment in the Clean Coal Technology (CCT) program. In preparation for new rounds of solicitations, as well as in negotiations of agreements for projects already awarded, I wanted to ensure that the state of-art technology developed under the CCT program would be appropriately valued by those who would eventually use it.

Bureaucratic inertia was evident in my questioning of the co-financing/ recoupment procedures then in place. Federal agencies are not, after all driven by economic or business interests, and approaches involving non-Federal financial involvement rendered the typical R&D process substantially more complicated. This I understood, and recognized that if the issue were to be treated with appropriate deference, then procedures would have to be established that would require it. The options available to me for institutionalizing the matter were to seek legislation, an Executive Order or a Secretarial order. I chose to pursue a Secretarial order as the most expeditious venue, while awaiting legislative opportunities. The Secretarial Order that I finally proposed was, as noted in the GAO report, set aside following my departure from DOE.

The issue was revisited during preparation of draft legislation that was submitted to Congress by the Bush Administration to carry out the policy recommendations of the National Energy Strategy. That draft legislation proposed tough provisions for R&D co-financing and for recoupment of the Federal investment. The end results of the debate, proposal and legislative counter proposal can be found in the Energy Policy Act (EPAct) of 1992.

This hearing provides an opportunity to re-examine what precisely was enacted in EPAct and whether the results are commensurate to the intent of Congress, which, I remind you, was very difficult to forge. I suspect, from the stated purpose of these hearings, from the report issued by GAO as well as the report of DOE's Inspector General[2], that the Clinton Administration has been highly selective as to the R&D provisions of EPAct it considers worthy of faithful implementation. It is nonetheless important to establish which aspects of the structure of R&D management are mandated by statute and which are left to the discretion of the Executive Branch, because only by so doing can we distinguish national from political policy.

EPAct on R&D Co-financing

As finally enacted, EPAct addresses the specific issue of R&D cost sharing—but not that of *ex post* investment recoupment—in several of its provisions. The first reference appears in Title VI, Subtitle A, section 614 related to electric motor vehicle commercial demonstration programs. It states: *"The Secretary (of Energy) shall re-*

---

[2] DOE/IG-0391: Report on Audit of Department of Energy's Activities Designed to Recover the Taxpayers' Investment in the Clean Coal Technology Program.

quire at least 50 percent of the costs directly and specifically related to any project under this subtitle to be from non-Federal sources. Such share may be in the form of cash, personnel, services, equipment, and other resources."

The common sense and clarity of this requirement is, however, undone in the section that immediately follows it, which states: *"The Secretary may reduce the amount of costs required to be provided by non-Federal sources . . . if the Secretary determines that the reduction is necessary and appropriate—*

1. considering the technological risks involved in the project; and

2. in order to meet the objectives of the subtitle."

As can be noted, the discretion provided to the Secretary of Energy to waive requirements for co-investment is exceptionally broad. The provision has apparently been interpreted by the Clinton Administration—the first Administration subject to EPAct—as meaning that waivers should be the rule rather than the exception. In truth, the provision lacks essential logic on at least two counts. First, *risk* in energy technology is more likely to be defined in the basic and fundamental phase of research rather than in the usually advanced demonstration stage. Secondly, it is difficult to envision the circumstances under which the objectives of a demonstration project are more likely to be met by less non-Federal investment. One could in fact argue—as I do below—that the contrary is most often true: the less the non-Federal involvement, the greater the likelihood of project failure. In any case, it should be noted that there are no requirements in Subtitle VI for recoupment of Federal investment after the technology is successfully demonstrated.

The second co-financing requirement of EPAct is found under Title XIII which addresses coal research. Here Congress addresses the need to recoup the Federal share of coal RD&D projects cost. Subsection 3(A) calls for a plan by the Secretary of Energy, to be submitted to Congress no later than 180 days after EPAct enactment, establishing " . . . *procedures and criteria for the recoupment of the Federal share of each cost shared demonstration and commercial application demonstration project ... Such recoupment shall occur within a reasonable period of time . . . but no later than 20 years following" completion of the project. /*

Once again, the clear and unequivocal intent of Congress and commensurably prudent public policy contained in the requirement of Title XIII is vitiated in the very next section, which provides to the Secretary of Energy broad authority to waive the recoupment requirement "*. . . as necessary for the commercial viability of the project."* Is it really conceivable that the usually modest licensing cost of a technology will actually jeopardize the commercial viability of a project that has been tested under the normally rigorous, cost-shared conditions typical of the clean coal demonstration program?

The third EPAct reference to cost-sharing of R&D appears in Title XXX, perhaps appropriately labeled "MISCELLANEOUS," where Section 3002 lays out the general requirements for the non-Federal share of R&D costs, as well as the view of Congress as to the conditions under which such cost-sharing shall be required. As will be noted, in this section Congress undermines the more demanding cost requirements it had established in earlier sections of EPAct, and opens the door for confusion in the implementation of this very critical aspects of national policy:

> *"Except as otherwise provided in this Act, for research and development programs carried out under this act, the Secretary shall require a commitment from non-Federal sources of at least 20 percent of the cost of the project. The Secretary may reduce or eliminate the non-Federal requirement under this subsection if the Secretary determines that the research and development is of a basic or fundamental nature."*

It is said that history never repeats itself, but that men always do. This is certainly the case in Federal involvement in energy R&D. The repetition lies in the recurrent confirmation that governments have historically done poorly as arbiters of winning and losing technologies. U.S. R&D history, a sample of which is provided below, proves this point admirably.

HISTORY OF POOR CHOICES

Energy R&D dates back to at least the Roosevelt Administration which determined—albeit at the height of WW II, when energy resources (oil especially) were critical to the war effort—that a national interest argument could be devised to justify Federal expenditures in otherwise private technological domains. The New Dealers of the Interior Department, under Secretary Harold Ickes made the first Federal investment in research and development of coal liquefaction and gasification technology. The technology was found economically unviable, as industry could have told Ickes, had it been asked, within two years of the Roosevelt Administration's initial investment, and abandoned. But only until Interior Secretary Krug revived it during the Truman Administration, again found it unviable, and shut the effort down after two fiscal years.

As expected, Federal investment in the same technology, again without private sector participation, was revived during the Nixon and Ford Administrations, with the same unviable results. The Carter Administration made the same mistake, when it once again financed R&D for the same by now thrice discredited technology, and wound up wasting $6.0 billion of the funds appropriated as part of the financing of the Synthetic Fuels Corporation.

There are, of course, numerous other examples of unilateral Federal R&D projects gone awry, such as the Clinch River Breeder Reactor, and of course, the perennial magnetohydrodynamic (MHD) technology: the most expensive method ever devised for burning coal to produce electricity. On the non fossil fuel side, there is the near half century effort on the part of Federal government to produce an electric vehicle, and the even more expensive investment in the permanent search for fusion energy.

The vast majority of Federal energy R&D choices and investments faced the same experience of coal liquefaction research throughout the 1970s and 1980s, with the exception of the Clean Coal Technology (CCT) program. In the CCT, Congress learned that private-public co-financing of R&D ensures relevance to policy objectives as well as likelihood of rapid, economic adoption of results.

The lesson of the CCT success seems not to have fully penetrated the R&D establishment, however. During my tenure at DOE I was more frequently confronted by calls to waive co-financing requirements than by recommendations to increase them. Inherent bureaucratic inertia works in perfect tandem with political expediency to increase rather than decrease the Federal R&D burden.

CONCLUSION AND RECOMMENDATIONS

My recommendation is a rather simple and obvious one: Congress should re-think the discretionary authority provided to the Secretary of Energy in EPAct on the issue of requiring co-financing and recoupment of Federal R&D investments. Congress should signal that waivers of these requirements should be the rare exception rather than the norm, and that each such exception should be justified on grounds credible not merely to government logic but to prevailing market practices. I would suggest that, at minimum, the following requirements be established unequivocally:

1. A minimum of 50% non-Federal investment for each and every R&D research and demonstration project, with no waiver authority whatsoever.
2. No co-financing requirement for basic and fundamental research.
3. R&D investment recoupment policy that follows prevailing licensing practices in the private energy technology sector, with no waiver authority whatsoever.

Mr. Chairman, my comments and recommendations are directed, in the main, to the civilian, non-defense portion of the R&D establishment, which is the sector with which I am most familiar. It may be that similar requirements would also be suitable for other R&D areas within and outside the mandate of the Department of Energy. I am a great believer that if government chooses to enter the field of applied R&D, a field in which the private sector is the principal agent of change, then it should do so for reasons of specific, economically quantifiable public policy. The expenditure of taxpayer funds should never, in my view, be justified on the vague, unverifiable grounds of the common good.

Mr. Chairman, this concludes my testimony. I shall be happy to try and answer your questions and those of other committee members.

Mr. ROHRABACHER. It is a lot of hassle and trouble to watch out for the taxpayers sometimes.

[Laughter.]

Mr. ROHRABACHER. Mr. Moore, thank you. I want to—we are going to get back to you with some questions after the other witnesses.

Let me just say, before we go to the other witnesses, I hope that we can—I do plan to follow through on this. Obviously there is bipartisan support for this concept in this Committee, and I hope that as we proceed we can call on your expertise to help us out.

Mr. Li, do you have a statement for us?

STATEMENT OF MR. ALLEN LI, ASSOCIATE DIRECTOR FOR ENERGY, RESOURCES, AND SCIENCE ISSUES, RESOURCES, COMMUNITY, AND ECONOMIC DEVELOPMENT DIVISION, U.S. GENERAL ACCOUNTING OFFICE

Mr. LI. Mr. Chairman and members of the Subcommittee: I am pleased to be here today to highlight the results of our report on DOE's recovery of its investment in technology development projects funded under contracts and cooperative agreements.

Four DOE offices plan to devote about $8 billion in federal funds to cost-shared projects, of which about $2.5 billion is currently subject to repayment.

I have two key points:

First, although DOE participates with the private sector in many cost-shared technology development programs, only four currently require repayment of the federal investment if the technology is commercialized.

These four programs are Clean Coal Technology, Metals Initiative, Electric Vehicles Advanced Battery, and Advanced Light Water Reactor, which requires repayment for some projects.

The mechanisms used for repayment in these programs are somewhat similar. All require a portion of royalty and fees from licensing technologies.

In three of the four programs and, to a limited extent, in the fourth, a percentage of revenues from commercial sales is also applied towards repayment. The Metals Initiative Program allows for recovery of 150 percent of the federal investment; where the other three are limited to 100 percent.

The time periods for repayment generally range up to 20 years after the projects end. So far DOE has been repaid a total of about $400,000, but it is still early in the process.

My second point. There are pluses and minuses to repayment, but minuses can be mitigated. The major advantage is of course that the government gets to recover some of its investment when technologies are successfully commercialized.

Also, having a repayment policy could discourage the submission of marginal proposals. Opportunities for greater use of repayment provisions do exist.

During our review, several senior DOE officials indicated that some technologies might be candidates for repayment if new projects are undertaken.

These could be projects with large federal investment, or those with technologies that are close to commercialization.

An example is the Advanced Turbine Systems Program. However, DOE officials also pointed out several disadvantages.

For example, some believe that repayment could discourage industry from commercializing technologies or participating in projects.

They were also concerned with the administrative burden imposed on themselves and on industry.

We do not minimize these concerns. In fact, our report offers ways to mitigate them. For example, one way of reducing the administrative burden might be to require repayment only when the amount of return justifies the cost of necessary audits.

The key here is to build in some flexibility in the policy. This is at the heart of our recommendation. It is interesting to note that DOE had at one time considered implementing a repayment policy.

As you heard, a draft was created that identified criteria and guidelines. However, as Mr. Moore just said, it went no further after his departure.

In conclusion, Mr. Chairman, we recognize that some types of projects may not be good candidates for repayment, and that disadvantages do exist. However, we believe that DOE can mitigate these disadvantages with a flexible repayment policy.

It should be stressed that cost recovery should not be a major objective in demonstration projects. However, opportunities may exist for substantial recovery of taxpayers' dollars if a flexible repayment policy is adopted.

Mr. Chairman, this concludes my statement. I will answer any questions after the panel is finished.

[The prepared statement of Mr. Li follows:]

United States General Accounting Office

GAO

Testimony

Before the Subcommittee on Energy and Environment,
Committee on Science, House of Representatives

For Release
on Delivery
Expected at
10:00 a.m. EDT
Thursday
August 1, 1996

ENERGY RESEARCH

Recovery of Federal Investment in Technology Development Projects

Statement of Allen Li, Associate Director
Energy, Resources, and Science Issues,
Resources, Community, and Economic
Development Division

Mr. Chairman and Members of the Subcommittee:

We are pleased to be here today to summarize the results of our recently issued report on recovering the federal investment in technology development projects.[1] At the Subcommittee's request, we (1) determined the extent to which the Department of Energy (DOE) requires repayment of its investment in cost-shared technology development, including the similarities and differences in the mechanisms used, and (2) identified advantages and disadvantages of repayment. We focused our work on four DOE offices--Fossil Energy, Energy Efficiency and Renewable Energy, Environmental Management, and Nuclear Energy--because they fund most of the Department's cost-shared technology development programs and projects involving contracts and cooperative agreements.

In summary, we found that:

-- DOE generally does not require repayment of its investment in cost-shared technology development projects. We identified only four programs in DOE that require repayment of the federal investment if the technologies are commercialized. The offices on which we focused our review plan to devote about $8 billion in federal funds to cost-shared projects, of which about $2.5 billion is subject to repayment. The mechanisms used for repayment are similar in that they generally require a portion of royalties and fees from licensing technologies and revenues from commercial sales. One program allows for recovery of 150 percent of the federal investment, while the other three are limited to 100 percent.

---

[1] Energy Research: Opportunities Exist to Recover Federal Investment in Technology Development Projects (GAO/RCED-96-141, June 26, 1996).

-- The major advantage of having a repayment policy is that the federal government could recover some of its investment in successfully commercialized technologies. However, according to DOE officials, repayment could also discourage some in industry from commercializing technologies or participating in projects, create an administrative burden on both DOE and industry, and cause technologies to become less competitive. We believe that many of the disadvantages can be mitigated by structuring a flexible repayment requirement with the disadvantages in mind. A flexible repayment requirement would allow the government to share in the benefits of successfully commercialized technologies that could amount to hundreds of million of dollars.

BACKGROUND

DOE and the private sector are involved in hundreds of cost-shared projects aimed at developing a broad spectrum of cost-effective, energy-efficiency technologies that protect the environment; support the nation's economic competitiveness; and promote the increased use of oil, gas, coal, nuclear, and renewable energy resources. The offices in our review are funding more than 500 projects under contracts and cooperative agreements with industry that are expected to cost more than $15 billion by the time they are completed. As we mentioned, DOE plans to fund about $8 billion and industry the balance.

FOUR PROGRAMS REQUIRE REPAYMENT

The four programs that require repayment are the (1) Clean Coal Technology Program, which accounts for about 90 percent of all current and planned funds subject to repayment; (2) Metals Initiative Program; (3) Electric Vehicles Advanced Battery Program; and (4) Advanced Light Water Reactor Program, which requires repayment for some projects in the program. The time periods for repayment to DOE generally range up to 20 years after the projects end. The Clean Coal Technology and Electric Vehicles Advanced Battery Programs allow grace periods before repayment begins if starting repayments earlier would adversely affect the competitiveness of the technologies in the marketplace.

DOE is investing more than $2.2 billion in the Clean Coal Technology Program through the year 2003. The funds have been committed to more than 40 demonstration projects that were selected in five separate rounds of nationwide competitions conducted from 1986 to 1993. These cost-shared projects demonstrate innovative technologies for using coal in a more environmentally sound, efficient, and economical manner. When the program began, DOE made a programmatic decision, in consultation with industry and the Congress, to require repayment of the federal investment if the technology is successfully commercialized. As the program matured, DOE revised the repayment provisions to respond to industry's concerns and lessen the likelihood that repayment could hamper the competitiveness of the project participants. Among other things, DOE reduced the percentage of revenues from technology sales that are subject to repayment, excluded foreign sales from repayment, and allowed a grace period before repayment begins to ease the technology's initial market penetration. As of June 30, 1996, DOE had received payments totaling about $379,000 from participants of four completed projects.

The Metals Initiative Program is the only program that allows repayment that exceeds DOE's investment. This program shares in the cost of research and development projects intended to increase energy efficiency and enhance the competitiveness of domestic steel, aluminum, and copper industries. Legislation requires repayment of up to 150 percent of the total federal investment from the proceeds of the commercial sale, lease, manufacture, or use of the technologies developed under the program. Repayment applies to both domestic and foreign sales. DOE has spent about $60.9 million for completed or terminated projects and plans to spend about $41.9 million for active projects. According to DOE officials, none of the projects have begun repayment yet, but repayment for one is expected to start later this year.

Under the Electric Vehicles Advanced Battery Program, DOE and a consortium of automobile companies, together with participating electric utilities and battery developers, are cost-sharing $206 million in development costs for advanced batteries to be used in electric vehicles. DOE is contributing about $103 million through 1996, and the other project participants are providing the balance. DOE expects to approve additional funding to continue this research after the participants submit their funding needs. As recommended in a Senate appropriations report, DOE requires repayment of its investment if the advanced batteries are commercialized. Repayment, which has not yet begun, applies to both domestic and foreign licensing revenues.

Some projects under the Advanced Light Water Reactor Program provide for repayment of all or part of the federal investment. This program's primary focus is to make standardized advanced nuclear reactors available in time to help meet the projected needs for future power generation. As recommended in an appropriations report, DOE is requiring the repayment of $14 million in additional funding provided for a project under the design certification component of the program. DOE also may require the repayment of any additional future funding for this project and another design certification project. DOE's original contractual commitment to these two projects is not subject to repayment. DOE also requires that its investment in two first-of-a-kind engineering projects aimed at producing more detailed designs and reliable construction schedules and cost estimates, which is expected to total $100 million, be repaid from royalties from the sale or use of the plant designs or technologies. Repayment, which has not yet begun, covers both domestic and foreign sales.

ADVANTAGES AND DISADVANTAGES OF A REPAYMENT POLICY

As we mentioned, the primary advantage of a repayment policy is that the government could recover some of its investment in the development of technologies. A repayment policy could also provide more assurance that industry cost-shared project proposals are sound and economically viable by discouraging proposals that are too marginal financially for their sponsors to commit to repayment.

In 1991, DOE considered having a Department-wide policy to recover its investment in technology development projects and developed a draft order with criteria and guidelines for determining when repayment is appropriate. But due to substantial opposition within the Department and the departure of the Deputy Secretary who was the primary supporter of this concept, the order was never implemented.

In discussing technology development programs and projects with DOE Deputy Assistant Secretaries and other DOE officials, many of them said that certain types of projects might be appropriate candidates for repayment of the federal investment if new projects are undertaken.[2] The officials generally indicated that repayment should be more applicable to projects with a large federal investment that is easily identified, projects involving technologies that are close to commercialization, projects in which the federal investment serves to reduce the costs and risks of providing the technology to potential users, and projects that have large, well-financed industry teams. They also said that technologies that have a large potential market and technologies that are likely to be commercialized in foreign countries are good candidates for repayment.

DOE officials indicated, for example, that the Reservoir Class Field Demonstration Program might be appropriate for repayment if future projects are undertaken. This program shares costs for demonstrations of existing and new technologies for increasing production from oil fields that might otherwise be prematurely abandoned. They also indicated that the Advanced Turbine Systems Program might be appropriate if new projects are begun. This program is intended to develop more efficient, advanced turbine systems for both utility and industrial electric power generation.

---

[2] DOE officials said that, except for the projects under programs that already require repayment, only new or follow-on projects should be considered for repayment because of the difficulty in renegotiating applicable cooperative agreements or contracts.

Many of the DOE officials generally indicated a willingness to consider repayment for new projects, but they said that flexibility should exist allowing them to structure repayment to meet program needs or waive repayment when not appropriate. For example, some officials believe that repayment may not be suitable for grants, universities, and small businesses or for projects that are directed at basic research. Others indicated that repayment should be waived if the federal investment is considered disproportionately small in comparison with the potential costs of administering the repayment process.

DOE officials also pointed out several disadvantages to the government or industry participants that would need to be addressed if repayment is required. Some DOE officials believe that repayment could discourage industry from participating in cost-shared projects or commercializing the technologies. We recognize that a repayment requirement might have some influence on participation in technology development projects or the timing of commercialization, but industry participants would not have to repay the federal investment unless the technology is commercialized. Therefore, repayment should be more favorable than a bank loan, which would have to be repaid with interest regardless of whether the technology is commercialized.

DOE officials generally believe that repayment would create an administrative burden in negotiating, administering, auditing, and enforcing repayment agreements. In our opinion, one way of making the administrative burden less onerous might be to require sample audits of industry participants' records. Another approach might be to require repayment only in those instances where the amount of potential return justifies the cost of necessary audits and other internal control measures.

Many DOE officials believe that obtaining increased industry cost-sharing is preferable to requiring repayment of the federal investment. Some officials argue that it may be better to obtain an increased cost-share from all participants than to obtain repayment only from those successfully commercializing their technologies. However, in our opinion, an argument can still be made that taxpayers have an interest in the repayment of taxpayers' dollars when technologies developed with federal funds are commercialized.

According to DOE, repayment might adversely affect the ability of the entity carrying out the project to compete in the marketplace (that is, to proceed with commercialization of the technology and achieve a rate of return commensurate with the industry and the risk). We believe one way of mitigating this concern could be to allow a grace period after a project ends before requiring repayment to begin (as was done in two of the programs that require repayment).

We recognize that some types of projects may not lend themselves to repayment for various reasons and that repayment has disadvantages. However, we believe it may be possible to mitigate the disadvantages in many cases by structuring a flexible repayment policy.

We recommended in our report that the Secretary of Energy develop and implement a Department-wide policy for requiring repayment of the federal investment in successfully commercialized cost-shared technologies. The policy should provide criteria and flexibility for determining which programs and projects are appropriate for repayment.

In commenting on a draft of our report, DOE did not explicitly state whether it would develop and implement a repayment policy. However, DOE agreed that any repayment policy should provide the flexibility for determining which programs and projects are appropriate for repayment. DOE believes that a policy should also have flexibility in determining the repayment terms, and when and how they should be applied so as not to adversely affect the development or introduction of technologies into the marketplace.

- - - - -

Mr. Chairman, this concludes our prepared statement, which has highlighted some of the information contained in our report. We will be pleased to answer any questions that you or Members of the Subcommittee may have.

(308892)

Mr. ROHRABACHER. Thank you very much, Mr. Li.

It will be interesting to know how we are going to determine whether or not someone is going to be able to receive back enough money to pay for the audit until you have had the audit to see if you are able to—anyway, you get the picture.

Mr. LI. Yes, sir.

Mr. ROHRABACHER. Anyway. Mr. Friedman.

STATEMENT OF MR. GREGORY H. FRIEDMAN, DEPUTY INSPECTOR GENERAL FOR AUDITS, U.S. DEPARTMENT OF ENERGY

Mr. FRIEDMAN. Mr. Chairman, unlike Secretary Moore who is now a free man, I am not in that category.

So if I deviate too much from the text, I will end up at the taxidermist's on my way back to the office.

[Laughter.]

Mr. FRIEDMAN. So bear with me.

I would like to summarize my testimony now and submit the full text for the record.

Our office has completed a number of audits in this area, the topic of the hearing, specifically audits concerning cooperative agreements and cost-sharing arrangements.

One of our objectives consistently has been to determine if the interests of the taxpayers have been given appropriate consideration in recoupment decisions relating to joint research and development projects.

In June of 1996, we issued an audit report on Departmental activities to recover to taxpayers' investment in the Clean Coal Technology Program.

The CCT is a Department and industry cost-shared partnership established to demonstrate and commercialize a new generation of advanced coal-based technologies.

The Department established a goal to recover an amount up to the taxpayers' investment in successfully commercialized Clean Coal Projects.

As of December 1995, the Clean Coal Program included 42 projects with a total cost of about $6 billion. The Department of Energy's cost share for these projects was approximately $2.3 billion.

The repayment agreements, which are separately negotiated with the private-sector sponsor, include specific language regarding the intent to recoup up to the full amount of the taxpayers' contribution to each project.

We analyzed 6 of the 42 Clean Coal Projects. The Department's cost-share for these projects was $151 million. The audit showed the Department's recoupment practices limited this opportunity to recover the taxpayers' investment.

Specifically, the Department exempted foreign sales, excluded some domestic sales, and lowered repayment rates. Further, decisions regarding these recoupment decisions were made without the benefit of formal economic analyses to determine their impact on the Department's goal of recouping the taxpayers' investment.

Because of its recoupment decisions, the Department limited its opportunity to recover an estimated $133 million of the $151 million in costs.

The Department exempted foreign sales from repayment agreements and thereby limited its opportunity to recover an estimated $120 million in four Clean Coal Projects.

This decision was made because of a general belief that sales of the technology would be in the domestic market. Also, the Department had concluded that it could not establish a mechanism to verify sales outside of the United States.

However, we found that the expansion of the foreign market for Clean Coal technologies was favorable and that international sales represented an important market for those technologies.

Further, we concluded that, given the international nature of today's business, designing a workable mechanism to verify sales should be feasible.

The Department's decision to exclude some domestic sales from its repayment agreements resulted in missed opportunities to recoup an estimated $12.7 million in two projects.

My formal testimony describes this in more detail, Mr. Chairman.

As the Clean Coal Program evolved, the Department made policy decisions to reduce the rate at which sponsors were required to repay their government share. The lower repayment rate may, in the final analysis, impact 20 Clean Coal Projects. On one project that had forecasted sales, this resulted in a lost opportunity to recoup an estimated $700,000.

Department officials believe that less stringent recoupment provisions would assist in making the technologies more competitive, lessen delays in the cooperative agreement negotiation process, and maintain industry's interest in the program.

However, economic analyses were not performed to determine the effect of these decisions nor their impact on the Department's goal to recoup up to the taxpayers' investment in the technology.

We recommend that the Department formally analyze and justify any decisions in future recoupment efforts that limit its ability to recover the taxpayers' investment, and Department management agreed with this recommendation.

I would also like to discuss this morning two audits dealing with cooperative research and development agreements, commonly referred to as CRADAs, at the Department's National Laboratories.

CRADAs are research and development agreements between the Department and the private sector. Generally the Department's work is carried out by one of its National Laboratories.

Our December 1994 Audit Report on Cooperative Research and Development Agreements at Sandia National Laboratory disclosed that the Department had not implemented appropriate policies to verify the contributions to the CRADAs from the non-federal sponsors.

A May 1995 audit of the CRADA Program at Los Alamos, Oak Ridge, and Lawrence Livermore National Laboratories disclosed that the Department's policy did not ensure an accurate valuation of CRADA-partner contributions. This paralleled the earlier findings at Sandia.

We recommended the Department establish a mechanism to ensure proper valuation of partner contributions to CRADAs. DOE management did not agree with our conclusion and recommendation.

Management contended that implementing rigid controls would undermine the success of the CRADA program and would limit the Department's ability to transfer technology to the private sector.

We believe the recommended controls that—the controls that we recommended, Mr. Chairman and Members of the Subcommittee, are not in fact rigid but are actually responsible actions which would assist the Department in achieving the goal of expanding research and development activities in a constrained budget environment.

Therefore, to this date, we are not in agreement with the Department's position on this matter.

This concludes my prepared remarks and I would be pleased to answer any questions that you or your colleagues might have.

[The prepared statement of Mr. Friedman follows:]

STATEMENT OF GREGORY H. FRIEDMAN, DEPUTY INSPECTOR GENERAL FOR AUDIT SERVICES, DEPARTMENT OF ENERGY

BEFORE THE SUBCOMMITTEE ON ENERGY AND ENVIRONMENT, COMMITTEE ON SCIENCE

U.S. HOUSE OF REPRESENTATIVES

AUGUST 1, 1996

Mr. Chairman and members of the Subcommittee, I am here in response to your July 18, 1996, letter of invitation to testify on funding for Department of Energy research and development in a constrained budget environment.

The Office of Inspector General has completed a number of audits in the general area of cooperativee agreements, cost sharing arrangements and the Department's recoupment decisions. One of our objectives has been to determine if the interests of the taxpayers have been given appropriate consideration in recoupment decisions on research and development joint ventures between the Government and the private sector.

As required by Public Law 98-473, Joint Resolution Making Continuing Appropriations for FY 1985 and for Other Purposes, the Department of Energy established a Clean Coal Technology Program (commonly referred to as CCT). The Department stated that the purpose of the program was to successfully demonstrate a new generation of advanced coal-based technologies and to stimulate the transfer of the most promising of these technologies into the domestic and international marketplace. The Department established a goal to recover an amount up to the taxpayers' investment in successfully commercialized projects.

On June 6, 1996, we issued an audit report on this subject, entitled, "Audit of Department of Energy's Activities Designed to Recover the Taxpayers' Investment in the Clean Coal Technology Program." Our audit showed that the Department's recoupment practices limited its opportunity to recover the taxpayers' investments. Decisions regarding these recoupment practices were made without the benefit of economic analyses to determine their impact on the Department's goal of recouping the taxpayers' investment. We recommended that the Department formally analyze and justify any decision in future recoupment efforts that limits the Department's ability to recover the taxpayers' investment in successfully commercialized technologies.

I would like to provide some background on the Clean Coal Technology Program. The CCT is a Department of Energy and industry cost-shared partnership established to demonstrate and commercialize a new generation of advanced coal-based technologies. It was envisioned that the CCT would play a major role in ensuring that the U.S. leads the world in developing, applying, and exporting sustainable, clean, and economically competitive energy technologies.

Under terms of the statute, the Department may not finance more than 50 percent of the total cost of any single project and may only share in project cost growth up to 25 percent of the originally negotiated Government share.

As of December 31, 1995, the Clean Coal Technology Program included 42 projects with a total estimated cost of $6.0 billion. The Department of Energy's cost share for these projects was approximately $2.3 billion while industry contributed about $3.7 billion. The projects were selected through five rounds of competitive solicitations over an 8-year period (1986-1993). Each cooperative agreement and ancillary documentation includes separate, negotiated terms which stipulate the Government funding commitment and the repayment responsibilities of the private sector sponsor. The repayment agreements are for 20 years and they include specific language indicating that it is the intent of the Government to recoup up to the full amount of the taxpayers' contribution in each project once the technology has been successfully commercialized.

The audit included an examination of the CCT recoupment practices for 16 of the 42 projects. A detailed analysis was performed for 6 projects where recoupment decisions have affected the ability of the Department to recover the taxpayers' investment. The Department's cost share for these 6 projects was $151 million. The audit disclosed that because of its recoupment decisions, the Department limited its ability to recover an estimated $133.7 million of this cost. We found that recoupment decisions which exempted foreign sales, excluded some domestic sales, and lowered repayment rates were made without the benefit of thorough, documented economic analyses.

EXEMPTION OF FOREIGN SALES

The Department limited its opportunity to recover an estimated $120.3 million in four clean coal projects by exempting foreign sales from the repayment agreements. We were informed that this decision was made because of a general belief that sales of the technology would be in the domestic market and that the Department had concluded that a mechanism could not be established to verify sales outside of the United States.

A 1994 report prepared by the National Coal Council and sponsored by the Department concluded that an expansion of the foreign market for clean coal technologies was favorable. The National Coal Council's conclusion was supported by one of the project sponsor's forecasts for technology sales, which showed foreign sales approximately 1 1/2 times larger than its forecast for domestic sales. Further, we found that 75 percent of the projected worldwide growth in coal use was expected to occur outside the United States. Thus, it appeared that international sales represented an important market for the clean coal technology.

Regarding a verification mechanism, we concluded that, given the international nature of today's business, such a mechanism should be feasible. Therefore, we did not find the argument regarding devising such a system for international sales to be compelling. We noted, at the time of our audit, that the Department had not established a verification system for domestic sales.

The decision to exempt foreign sales from recoupment has an even greater impact when looking at the entire program. The foreign sales exemption applies to an additional 19 clean coal projects that will be completed in the future. The Department has invested over $1.4 billion in these projects. The exemption will greatly limit the Department's ability to recover the taxpayers' investment in successful commercialization of the projects outside the United States.

EXCLUSION OF SOME DOMESTIC SALES

The Department's decision to exclude some domestic sales from its repayment agreements resulted in missed opportunities to recoup an estimated $12.7 million on two projects.

The audit disclosed that the Department invested $17 million to demonstrate the technology in one project, and that this demonstration was instrumental in the successful testing and commercialization of the technology. The exclusion exempted $2.5 billion in sales in this project that could have resulted in a repayment of $12.5 million. According to a Department official involved in this project, the rationale for excluding these domestic sales was that the Department was not involved in the project initially and that the technology owner was not a recipient of any of the Department's funding for the project. We believe that it would have been appropriate for the Department to seek recoupment of its investment from sales of the technology.

The second project had $200 million in sales which would have resulted in $200,000 in recoupments. The Department contributed $63.9 million to this project without a repayment provision for sales made during the demonstration period. A Department official involved with this project stated that these sales were exempted because the Department did not believe that sales of the technology would occur prior to completion of the demonstration phase. However, we found that the demonstration phase lasted 3 years, and that some successful test results were available prior to the end of this phase. The benefits associated with the technology were recognized in the marketplace and an order for the technology was placed prior to completion of the demonstration phase.

REDUCTION OF REPAYMENT RATES

Based on forecasted sales, the Department's decision to decrease repayment rates on projects resulted in a lost opportunity to recoup an estimated $700,000 on one project. The general guidance for Round I of the program did not include specific repayment rates. However, the guidance became more specific in Round II when the Department established a repayment rate policy at 2 percent of gross revenues. In Rounds III, IV, and V, the Department reduced the repayment rate policy to 0.5 percent of gross revenues.

Two additional participants in the project were a state agency and a utility association. Both parties provided funds to the project sponsor and negotiated separate repayment agreements with the sponsor based on the successful commercialization of the technology. Based on forecasted sales of the technology, we calculated that the Department can expect to recover 4.7 percent of the taxpayers' investment, while the state agency will recoup 41.3 percent of its investment and the utility association will recoup 9.5 percent of its investment. Because of the change in the Department's recoupment rate, the taxpayers will recover substantially less than the other project participants.

The Department indicated that the recoupment rates were reduced to bring them more in line with current business practice. However, there was no documentation to support the Department's contention that there was a model in current business practice that applied to the CCT situation or that 0.5 percent was an appropriate business rate to be used on projects of this type. In fact, an industry official indicated that the repayment rate of 0.5 percent was too low and that it should have been between 1 and 5 percent depending on the technology's commercial potential. The audit disclosed that this lower repayment rate may impact 20 additional projects negotiated in Rounds III, IV, and V.

BASIS FOR RECOUPMENT DECISIONS

Department officials believed that their less stringent recoupment provisions would assist in making the technologies more competitive, lessen delays in the cooperative agreement negotiation process, and maintain industry's interest in the program. However, an economic analysis was not performed to determine the effect of the decisions nor their impact on the Department's goal to recoup up to the taxpayers' investments. As a result, we recommended that the Department formally analyze and justify future recoupment decisions that limit the Department's ability to recover the taxpayers' investment. Management concurred with our recommendation.

In 1991, consistent with our finding and recommendation, the U.S. General Accounting Office (GAO) issued a report, "Improvements Needed in DOE's Clean Coal Technology Program," which recommended that the Department analyze the effect that recoupment provisions have had on industry participation in the CCT Program and the likelihood of recovering the Federal investment. The GAO also recommended that this analysis should be, the basis for DOE to reevaluate its recoupment policy, specifically, to determine whether it should be strengthened to provide greater assurance that the Federal investment in successfully demonstrated technologies will be recovered. Our audit revealed that the Department had not taken any action to satisfy the GAO's concerns.

RECOUPMENT PROCEDURES

In order for the Department to meet its intended goal of recouping up to the taxpayers' investment, controls should be established to ensure that moneys for which the Government is entitled are tracked, accounted for, and verified. The Department had not established any formal financial recoupment policies and procedures, nor had it instituted any mechanism to monitor clean coal project repayments. A Department official acknowledged that a financial policy for the recoupment of the taxpayers' investment in clean coal projects did not exist.

We recommended that the Department establish financial policies and procedures over Departmental recoupment activities and implement mechanisms to ensure that sponsor repayments are timely, accurate, and complete. In responding to our report, the Department stated that it planned to develop such policies and procedures for inclusion in the Department's Accounting Handbook. This action is expected to be completed by January 31, 1997. In addition, as a result of the audit, the Department created a Repayment Process Improvement Team which recommended actions to track, account for, and verify moneys due from sponsors.

COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENTS

I would like to discuss two audits dealing with cooperative research and development agreements at the Department's national laboratories. The Department of Energy contracts with management and operating contractors to operate its national laboratories. The laboratories are involved in multiple areas of research and development in science and nuclear technologies. This includes efforts to transfer technology developed at the laboratories to the private sector. One of the mechanisms used to achieve this goal is the Cooperative Research and Development Agreement (CRADA). As part of these agreements, the Government contributes facilities, personnel, and equipment, commonly referred to as funds-in-kind, while the private sector partner may make cash payments to the Government in addition to its own in-kind contributions. The Department intended that CRADAs provide mutual benefits to the Department and industry, such as leveraging scarce research and development resources, increasing the exchange of ideas, and providing access to facilities, equipment, and experts.

To put the use of this type of agreement in some perspective, as of November 1994, the Sandia National Laboratories, one of the Department's largest laboratories, had 210 agreements totaling approximately $546 million. The Department's cost share for these agreements was about $241 million. Of the industry partners' $306 million cost share, about $272 million was in-kind, with the remaining $34 million being cash payments to the Department. Our December 30, 1994, report, "Audit of Verification of Cooperative Research and Development Agreement Partner Funds-In-Kind Contributions at Sandia National Laboratories," disclosed that current practices were inadequate for verifying partner in-kind contributions.

We also audited the Department's administration of CRADAs at several other national laboratories. That audit report, issued on May 19, 1995, disclosed that efforts to manage cooperative research and development agreements at Los Alamos, Oak Ridge and Lawrence Livermore National Laboratories did not fully achieve the Department's policy goals. As was the case in our earlier audit at Sandia, we found that agreement provisions did not ensure an accurate valuation of partner contributions. Specifically, we found that: (i) the three laboratories did not employ standard accounting and audit procedures with appropriate tracking of funds to verify the value partners assigned to their in-kind contributions; and (ii) the Department established cost sharing goals without any mechanism to validate that partners were meeting their cost share commitments. As a result, we recommended that the Department establish a mechanism to ensure proper valuation of partner contributions to CRADAs. DOE management did not agree with our conclusion and recommendation. In responding to our report, management contended that implementing rigid controls would undermine the success of the CRADA program and would limit the ability to transfer technology to the private sector. We believe the recommended controls are not "rigid," but are responsible actions which would assist the Department in achieving the goal of expanding research and development activities in a constrained budget environment. Therefore, we are not in agreement with the Department's position on this matter.

This concludes my prepared remarks, Mr. Chairman. I will be pleased to answer any questions you and your colleagues may have.

Mr. ROHRABACHER. Thank you, very much. There are several questions that come to mind.

Mr. Lewis?

STATEMENT OF MR. ROGER A. LEWIS, SENIOR ADVISOR, OFFICE OF STRATEGIC COMPUTING AND SIMULATION, OFFICE OF DEFENSE PROGRAMS, U.S. DEPARTMENT OF ENERGY

Mr. LEWIS. Good morning, Mr. Chairman, members of the Energy and Environment Subcommittee. I am Roger Lewis, a Senior Advisory in the Office of Defense Programs.

It is a pleasure to appear before you in response to your invitation of July 18, 1996, to Secretary of Energy O'Leary.

I have submitted a written statement for the record and would like to briefly summarize it, emphasizing the following four points:

The Department of Energy recognizes the need to identify additional means of cost-sharing or leveraging other resources to better accomplish our research and development activities.

We agree that additional work can and is being done in this area.

We believe that there are circumstances where an over-emphasis on cost-sharing or recoupment could make agreement to work on shared problems more costly and difficult, resulting in lower research and development performance.

We desire to work with the Subcommittee and others in Congress to identify and address other areas where improvements could result in lower research and development costs to the taxpayer, and additional nonfederal funds being apply to pay for research and development activities.

We applaud the initiative that you, Mr. Chairman, and Members of the Subcommittee, have shown in holding this hearing to address funding Department of Energy research and development in a constrained budget environment.

We agree that the use of creative methods to defray the cost of funding DOE R&D programs will become and, we submit, have already become, increasingly important.

The Department of Energy has not, as a general practice, explicitly addressed recoupment in developing its research and development strategy on either a program or project basis unless specifically directed to do so by the Congress.

It is desirable for the Department to develop general principles and criteria to address cost-sharing and recoupment on a more comprehensive and consistent basis.

However, we should also note that attempts to recoup costs necessarily involve complex trade-offs between front-end costs to the government versus future-year recoupment.

There is no free lunch.

Generally speaking, the higher the future recoupment requirement, the greater will be the government's front-end cost of achieving a given project.

Also, the government is engaged in a wide variety of R&D activities. Some are totally basic research in nature, where others are at varying points in the applied R&D spectrum.

The more basic the research is, the lower the potential for recoupment, since the benefits of basic research often cannot be sufficiently appropriated by those who pay for it.

Nevertheless, the Department has looked at these issues in the past and is doing so at present. While the actual amount changes over time due to project completion, project changes, and in some cases termination activities, we estimate that between $1 billion and $1.5 billion of our research and development activities are currently cost-shared.

Because of the current austerity in research and development budgets and specific reductions in technology transfer partnership programs, the level of cost-sharing has not been growing and we believe is somewhat less this year than last.

An example of a successful use of cost-sharing are the Department's CRADAs. The Department averaged 44 percent of the total investment in Cooperative Research and Development Agreements against a 56 percent partner contribution when all the CRADAs are reviewed collectively.

In programs that are more applied such as energy efficiency, for example, the partner contribution can be as high as 65 percent, while in the more basic research programs such as those of energy research the federal share typically would be more than the 44 federal share average.

As provided by statute, we can accomplish our work either solely with our own resources, or by involving others on either a cost-share or fully funded basis.

We seek public funds to accomplish specific mission activities, and use cost-shared agreements and other tools as part of effective program management to achieve the Department's objectives.

In selection of an approach to leveraging federal R&D dollars, the selection ultimately depends on what purpose one is trying to achieve.

If one is trying to incentivize industry to develop a technology for broad social purposes, then cost-sharing could be considered a form of investment in the other party.

In some cases, the taxpayers' investment payoff could be obtained outside the confines of the research and development project, for example by providing a cleaner environment and improved quality of life.

This may be the case if DOE is promoting the development of a new energy-efficient technology.

If the purpose is to develop technology to address a pressing mission requirement such as developing a technology to help clean up a Department of Energy site and to comply with regulatory standards and criteria, then cost-sharing is primarily the means of reducing the taxpayers' ultimate cost and compensating the other party for their investment in our problem by providing them reasonable access to the resulting technology and intellectual property for their purposes.

We pledge to work with this Committee and others in the Congress to improve the effectiveness and efficiency of our R&D programs and identify areas where additional statutory authority is required.

In addition to exploring cost-sharing arrangements and recoupment, the Subcommittee might also wish to review the opportunities and barriers to the nonfederal reimbursable use of our laboratories and facilities.

Often we are told that promising interactions fail to come to closure because of barriers to our reimbursable use of our facilities.

If we can accommodate additional appropriate work using existing under-utilized capacity, then we reduce the net overhead costs the Department of Energy bears and increase the direct research and development buying power of our appropriations.

This could have a substantial positive impact in this constrained budget environment.

We thank you for the opportunity to appear before you today, and we will be happy to respond to any questions.

[The prepared statement of Mr. Lewis follows:]

STATEMENT OF ROGER LEWIS

UNITED STATES DEPARTMENT OF ENERGY

BEFORE THE SUBCOMMITTEE ON ENERGY AND ENVIRONMENT

HOUSE COMMITTEE ON SCIENCE

AUGUST 1, 1996

Good morning, Mr. Chairman and members of the Energy and Environment Subcommittee. I am Roger Lewis, a senior advisor in the Office of Defense Programs. It is a pleasure to appear before you in response to your invitation of July 18, 1996 to Secretary of Energy O'Leary.

We applaud the initiative that you, Mr. Chairman and members of the Subcommittee, have shown in holding this hearing to address funding Department of Energy (DOE) Research and Development (R&D) in a constrained budget environment. We agree that the use of creative methods to either fund or to defray the cost of funding DOE R&D programs will become, and we submit already has become, increasingly important. So we approach this hearing from the perspective of shared recognition with the Congress on the importance of this issue and the need to maximize the effectiveness of the taxpayers' research and development investments.

The Department of Energy has not, as a general practice, explicitly addressed recoupment in developing its research and development strategy on either a program or project basis, unless specifically directed to do so by the Congress. It is possible and probably desirable for the Department to develop general principles and criteria to address cost-sharing and recoupment on a more comprehensive and consistent basis. At a minimum this would help address concerns regarding whether we are maximizing the buying power of the taxpayers' investment.

However, we should also note that attempts to recoup costs necessarily involve complex tradeoffs between the front-end costs to the government versus future-year recoupment, among other tradeoffs. There is no free lunch. Generally speaking, the higher the future recoupment requirement, the greater will be the government's front end cost of achieving a given project. Also, the government is engaged in a wide variety of R&D activities: some are totally basic research in nature, while others are at varying points on the applied R&D spectrum. The more basic the research is, the lower the potential for recoupment, since the benefits of basic research often cannot be sufficiently appropriated by those who pay for it. Nevertheless, the Department has looked at these issues in the past, and is doing so at present.

The Department currently employs two basic approaches to leverage taxpayers' R&D dollars—cost-sharing and recoupment. The Department also charges user fees at some specialized research facilities to cover the incremental cost of the use of those facilities by other organizations for proprietary or commercial work. Of these, cost-sharing is the principal mechanism used by the Department for this purpose.

In specific instances, the Congress has required the Department to negotiate recoupment provisions as part of major programs. And while the Department has some arrangements that call for the recovery of all or part of the Department's investment from successful commercialization, such as the advanced light water reactor program, there has been relatively little repayment generated up to this time. Major programs within the Department were the subject of a recent U.S. General Accounting Office report for the Subcommittee—"Energy Research: Opportunities Exist to Recover Federal Investment in Technology Development Projects," GAO/RCED-96-141, June 26, 1996—which included the Department's comments.

COST-SHARING AND LICENSING

While the actual amount changes over time, due to project completion, project changes and, in some cases, termination of activities, we estimate that between $1 billion and $1.5 billion of our research and development activities are currently cost-shared. Because of the current austerity in research and development budgets, and specific reductions in technology transfer/partnership programs, the level of cost-sharing has not been growing, and we believe is somewhat less this year than last.

An example of a successful use of cost-sharing are the Department's CRADAs. The Department averaged 44 percent of the total investment in Cooperative Research and Development Agreements (CRADAs) against a 56 percent partner contribution when all CRADAs were reviewed collectively. In programs that were more applied, such as Energy Efficiency for example, the partner contribution can be as high as 65%, while in more basic research programs, such as those of Energy Research, the federal share typically would be above the 44% federal share average. Cost-sharing ratios can vary substantially among agreements.

Large-scale cost-sharing programs, such as the Clean Coal Technology program, have an institutionalized cost-sharing process as part of the negotiating process to reach a specific agreement. In the case of other research and development activities, the Department designs the research program broadly and takes advantage of cost-shared and other collaborations that arise in response to announcements, outreach, or partner initiative. In either case, we work with the Congress to identify the funding requirements needed to accomplish specific objectives and bodies of work. As provided by statute, we can accomplish this work either solely with our own resources, or by involving others on either a cost-shared or fully-funded basis. We seek public funds to accomplish specific mission activities, and use cost-shared agreements and other tools as part of effective program management to achieve the Department's objectives.

Typically, licensing agreements should not be considered as cost shared. The Department of Energy, or our laboratories and facilities, expends funds for patenting and copyright processing, patent prosecution, and patent maintenance. We can apply some of the royalties received against the accounts that bore those costs.

Some inventions are owned by DOE. In FY 199S, twelve licenses for commercial practice of DOE-owned patents were granted. These agreements allow for commercial use of inventions covered by DOE-owned patents, and are generally subject to royalties and reporting provisions. All licenses granted in 1995 were nonexclusive, although authority to grant exclusive licenses in some circumstances exists. Most of the licensing activities are conducted, pursuant to statute, by our contractor-operated laboratories and facilities. And since most of future licensing revenue is currently earmarked by statute for inventors (this was enacted as part of P.L. 104-113), this activity appears to have little potential to reduce DOE's budget.

DEPARTMENTAL AUTHORITY

R&D support is provided by DOE to the recipient by procurement contracts, grants or cooperative agreements. The provisions of procurement contracts follow the guidance provided in the Federal Acquisition Regulations and the DOE Acquisition Regulations (DEAR). The provisions for grants and cooperative agreements follow the guidance provided in the DOE Financial Assistance Regulations at 10 CFR 600. Specific requirements for cost sharing are found at 10 CFR 600.123. The DEAR contains instructions on cost "participation" at Subpart 917.70. (48 CFR 917.70). The DEAR is couched in terms of policy rather than contract clauses. It states at 917.7001(d) that cost participation is required for demonstration projects unless exempted by the Under Secretary. DOE has no general regulations specifying terms and conditions for transactions that might provide for recoupment.

The Department does have a Model CRADA, as required by law, and follows Federal acquisition and financial assistance regulations in its contracts and grants/cooperative agreements, and these provisions are published and available—they reflect the broad framework. Individual agreements often have variations of clauses, and in some cases unique terms. The Department approaches cost sharing from the perspective that our partners' contributions are reducing the taxpayers' cost and risk with their investment and, as provided by law, are entitled to reasonable recognition, such as rights in resulting intellectual property.

CRADAs are submitted to DOE for approval by the contractor operating an eligible facility. General policy guidance and approved terms and conditions are set forth in the "Modular CRADA" which is made available to the contractors, contracting officers and the public.

The Department's formal regulations, guidance, and policies covering cost sharing are found at 10 CFR 600.123. The DEAR contains instructions on cost "participation" at Subpart 917.70 (48 CFR 917.70).

Licensing of Government-owned patents is authorized by 35 U.S.C. 207-209, and implemented by Government-wide regulations issued by the Department of Commerce, 37 CFR 404. The regulations specify policies, criteria and procedures for such licensing. These regulations are currently under review by Commerce and an interagency task force for purposes of, among other things, streamlining exclusive license procedures. Technology Transfer Regulations governing contracts for the operation of DOE facilities where the contractor has been given the authority to license inventions and receive royalties are found at 48 CFR 970.5204-40.

Per 35 USC 200 (Bayh-Dole), and as authorized by the Atomic Energy Act of 1954, 42 USC 2182 and section 9 of the Federal Nonnuclear Energy Research and

Development Act of 1974, 42 USC 5908 in furtherance of the Presidential Memorandum to the Heads of Executive Departments and Agencies on Government Patent Policy issued February 18, 1983, and Executive Order No. 12591 issued April 10, 1987, most inventions arising from DOE funded research are owned by the contractor making the invention, without provision for return of royalties to DOE. Contractors operating DOE facilities receive royalties from the licensing of technology which they own. Their royalties are shared with the inventors or used at the facility. Sections 35 USC 202 and 15 USC 3710a-3710c govern royalties received by the facilities.

DOE implemented the cost sharing requirements of EPACT immediately upon enactment, and issued final guidelines in March 1996 by Acquisition Letter 96-04 and Financial Assistance Letter 96-01.

ISSUES

The selection of an approach to leveraging federal R&D dollars ultimately depends on what purpose one is trying to achieve. If one is trying to incentivize industry to develop a technology for broad social purposes, then the cost-sharing could be considered a form of investment in the other party. In some cases the taxpayers' investment pay-off could be obtained outside of the confines of the research and development project, for example by providing a cleaner environment and improved quality of life. This may be the case if DOE is promoting the development of new energy efficient technology. If the purpose is to develop a technology to address a pressing mission requirement, such as developing a technology to help clean up a Department of Energy site and to comply with regulatory standards and criteria, then cost sharing is primarily a means of reducing the taxpayers' ultimate costs, and compensating the other party for their investment in our problem by providing them reasonable access to the resulting technology and intellectual property for their purposes.

While we are mindful that the Subcommittee is interested in understanding the strengths and weaknesses of different approaches, we do not think they are fully interchangeable. Recoupment could be addressed within these other agreements and in itself is not a typically a stand-alone agreement. A CRADA is different from a contract, grant or cooperative agreement in that while there is cost-sharing, no federal funds go to our partners. The purpose of a CRADA is to share the value of joint efforts and to maximize the impact of the scarce resources of all parties.

We pledge to work with this Committee and others in the Congress to improve the effectiveness and efficiency of our R&D programs and to identify areas where additional statutory authority is required. In this regard, we know of no barrier to the Department pursuing any research activity on a cost-shared basis. The Department could assert authority to require recoupment, ex ante, in those agreements in which federal funds are provided to our research and development partners. It is not clear that where there is cost-sharing, but the federal funds remain with the federal activity, such as under a CRADA, that there is clear authority to seek to negotiate recoupment.

The Department has examined the issue of recoupment, or investment offsets, from time to time, most recently during the tenure of Deputy Secretary Moore. From our perspective, requiring a universal recoupment provision in all of our R&D projects poses significant costs and creates significant barriers to collaboration. It would require that the Department administratively maintain a tie to a large number of contracts, grants, financial assistance agreements, cooperative agreements, and potential CRADAs and other agreements, long after they are completed.

Not every research and development agreement will lead to a commercially viable outcome. In the private sector it is considered good, according to several studies, if fifteen percent of the research and development activities get incorporated into a product line and generate revenue. There are a few home runs, a number that break even, and a number that don't pan out and are treated as losses. We would need to treat every agreement as a potential "winner" and incur the negotiation, monitoring, and audit costs as a result. Also, because the funds recouped would go directly back to the Treasury, the Department would be increasing its administrative expenses without a commensurate return at a time these resources are being reduced, even if there was a revenue stream generated. Under present law, such revenues would not defray the Department's expenses, nor provide an alternative source of funds for the Department's own R&D activities.

It is also important to note that negotiations on recoupment would be difficult and complex, especially when trying to determine the value of an incremental improvement to an existing product (such as a small percentage improvement in engine efficiency), as opposed to an entirely new product. The Department currently does negotiate royalty bearing licenses. In some discussions it has been suggested that royalty payments be deducted from the amount to be recouped. It is thus not clear how much additional revenue, if any, we are likely to generate and how to compare it to the human and financial cost of administering this process and its effect on our partners' interest in working on these public projects.

From the partner's point of view, recoupment lessens the incentive to participate in the Department's activities and may consequently increase the cost to the taxpayer of individual projects. The partner may also be wary of accepting a potentially unlimited period of time during which he would be liable to a contract audit, and other investigations. Small businesses, especially, may prefer not to partner. If there is a decrease in partnership activities, the taxpayers could lose the anticipated benefits of partner business success and investment. Also, other public benefits could be lost if an arbitrary federal recoupment requirement made the financial break-even/profitability hurdle too high.

CONCLUSION

Mr. Chairman and members of the Subcommittee, the Department of Energy has been exploring, and will continue to explore, the most effective and appropriate ways of funding our research and development activities. We share with the Subcommittee the belief that we can expand the utilization of non-Federal funds in the accomplishment of Federal Research and Development activities. In May of this year, Deputy Secretary Charles B. Curtis directed that a study of R&D leveraging and financing alternatives be conducted within the Department. We expect the study to be completed before the end of the year and intend to share the results of this work with the Subcommittee and the Congress.

In addition to exploring cost-sharing arrangements and recoupment, the Subcommittee might also wish to review the opportunities and barriers to the non-federal reimbursable use of our laboratories and facilities. Often, we are told, promising interactions fail to come to closure because of barriers to the reimbursable use of our facilities. If we can accommodate additional appropriate work without adding capacity, the Nation gains. If we can accommodate additional appropriate work using existing underutilized capacity, then we reduce the net overhead cost that the Department of Energy bears, and increase the direct research and development buying power of our appropriations. This could have a substantial positive impact in this constrained budget environment. We hope that you will consider these as well as other meritorious ideas that this hearing and other efforts of the Subcommittee may identify.

We thank you for the opportunity to appear before you today and would be pleased to respond to any questions you may have.

Mr. ROHRABACHER. As you can hear by the bells going off, we have two votes I believe that we face here. So instead of proceeding with the questions, I am going to break this hearing until immediately after the second vote, which should be about 15 minutes.

So thank you very much. We are in recess for 15 minutes.

[Brief recess.]

Mr. ROHRABACHER. This hearing will come to order.

I just had some interesting discussions about this subject on the Floor where several of the more veteran Members told me that, while it was a good idea, forget it! Henson Moore tried to do that a long time ago, and——

[Laughter.]

Mr. ROHRABACHER. But, you know, here we are cutting people off of welfare. For the first time, this Congress has made a determination that the poor people of this country are not served well by making them dependent on government largess.

We cannot in good faith cut poor people off of welfare while we permit large corporations to make tens of millions, and hundreds of millions of dollars of profit basically at the expense of the taxpayer when the taxpayer has provided a subsidy to that that they do not get back.

If we do not take on big business and basically the welfare that goes in their direction, I do not see how we can in good faith go after the little guy and say we are going to cut you off of the welfare dole.

So that is just the moral implications, but there is a practical implication to this as well. That is, if we do not require a payback, businesses that could do the job on their own are inclined to ask the government for money. Why not?

If we do not require the money to be paid back, if we are providing money for research that develops a new product for a company, that company will not go to the private sector to raise that money even though it can; and it seems to me that again at a time when we are cutting programs which we believe—you know, we are trying to cut out everything that is not absolutely necessary for the government to do for the average person, for the average citizen—for us not to set that same criteria for the corporate world is not only inconsistent, it is an abomination.

Because what we have here, we are talking about some corporations that are making huge profits. And there is nothing wrong with huge profits as long as people have taken the risk with their own money in order to make those.

And that will lead into my questions here because—and, by the way, if a corporation can go to a private-sector source and get the money that is needed to set up a laboratory, or to do the scientific investigation, well, then, that company should go in that direction.

We should not be using scarce dollars to do what can be done in the private sector. These are some of the fundamental issues that we are talking about today.

So, Mr. Moore, is the senior fellow who just told me to forget it, should we just forget it? Or do we have a chance to actually accomplish something here?

Mr. MOORE. Mr. Chairman, I would urge you not to forget it. I think that you are talking about a culture change.

One thing we learned in the Department of Energy when I was there was that culture changes take longer than two, or three, or four, sometimes as long as five or six years to implement.

You are talking about basically, certainly, changes in the law, seeing that the law is being implemented and followed, but you are also talking about a culture change in the laboratories, in DOE, and even the members of this Committee, where everybody gets on the same parallel soundtrack that, by golly, we are interested in cost-sharing. We are interested in recoupment, and we intend to see it happen.

When that culture change takes place, you will find all the problems that I encountered in the early years of trying to change that culture disappear.

I think it is important that we keep the National Laboratories in existence. They are, as we used to say in our time on duty, on deck, national jewels.

Some of the finest minds in the world are in those laboratories. It is not going to be possible to continue to fund them at even today's levels with the appropriations. You can look at the trend lines.

This offers a way to have the money come back, to continue to bring about new research and development projects that maintain the vision and the technological lead the United States is known for.

So it is both, as you say, a moral question of people not getting something for nothing and paying for it, which they would do in the private sector; but it is also a matter of it is the way, I think, to come up with the funds to maintain one of the leading research programs in the world.

Mr. ROHRABACHER. Where the moral and the practical arguments come together, I think that that is——

Mr. MOORE. Absolutely.

Mr. ROHRABACHER. It is incumbent upon us to move forward in that direction.

Mr. Lewis seemed to indicate there would be some problems.

And, Mr. Lewis, with all due respect, your testimony reminded me a little bit of the adage about what Ronald Reagan used to say about experts. He used to say, you know, go to an expert and he will tell you every reason why something cannot be done. You certainly did outline some of the problems that we would have in accomplishing this.

Mr. Moore, do you have any comments specifically on Mr. Lewis' testimony? And, Mr. Lewis, you can feel free to give your retort.

Mr. MOORE. I think I have heard most of what Mr. Lewis had to say before. I think there was one interesting new comment, and that was the fact that there is a sociological reason and advantage to getting these things out of the hands of the public and not worry about, or not make that dependent upon cost recoupment or cost sharing. That is a philosophical difference.

That is not one that I guess we shared too heavily on our watch. It was one that we look at the other way around. If it was a great idea, the people would be willing to pay to put it on the market.

Now basic research, we are not talking about that. We are talking about applied research. So basic research fits I think the description Mr. Lewis gave.

The development of weapons' systems agrees with that.

Almost anything else you can think of that has a commercial application I think you need to look very hard at, "Why won't people pay for it?"

I learned a lesson early in life that I taught my children. We had a Collie female and she had puppies by a non-Collie father. I put an ad in the paper, "Free, Half-Collie Pups." Two weeks went by and not a single call.

I put an ad in the paper saying, "Half-Collie pups, $25." I sold them all the first day.

[Laughter.]

Mr. MOORE. That taught me a very valuable lesson. If it is free, it is not worth anything, or people are not going to offer to pay for it. If you put a price to it, businessmen understand that, and they will come to the door and they will work with you.

Mr. ROHRABACHER. All right.

I am going to—I guess Mr. Roemer is not here—Mr. Baker would be next, and then I will come back and ask some further questions.

Mr. BAKER of California. Okay, if we can now move on past the price-fixing on pharmaceuticals and other quick fixes, I think the time for debating whether or not we are going to charge for research is over.

Obviously, if we want to get products from let's say the defense side of the laboratories into the commercial side, we have to find a mechanism to do that.

There will be less and less money spent on research if we do not find ways to do it. So I think the debate is over.

The question is: do we charge up front? Do we charge to get recoupment? Or do we look for winners and then license, and then forever have a return?

Then, secondly, which takes out the onus of coming up with the money in the first place, but when a product is a winner we become a licensing agent, and in Mr. Rohrabacher's pharmaceutical example we would have been a one percent partner forever. We would not have to fix their price or do any other heavy-handed government intervention, but if a pharmaceutical became a marketable item, we would win. If it does not, nobody wins. But we should not restrict research just on the basis of somebody's ability to pay.

But when we do get a winner, we want our share.

Secondly, are we an end user?

Are we working with people that want to fix a machine for their marketing process or manufacturing process?

If so, they pay a small fee because we have an expertise and we share that with them and a manufacturer.

But if they are making a product that goes out world-wide, then we become licensing agents.

I think we will not then prevent people from coming to us. We instead will just become their partner. I think it is very important that we work out these mechanisms within the laboratories that we share.

Third, we have to decide whether we are going to have a research account, because incentives work. I do not know about Collie pups, and I do not know about vets and taxidermists, but I do know if we say to a laboratory, if your secrets can be marketable with company X and you work in a CRADA or some other agreement, and they become successful, you are going to get X number of dollars back in a research account which comes back to your laboratory through the regular budgeting process.

I do not believe in slush funds hidden away at the various laboratories, but if we had a research account and 20 percent of that was going to go to Oak Ridge, then Oak Ridge would have an incentive to market their products and have a return on those products because then they would pay for future research.

So I think mechanisms can be established which will allow our great treasures, as Mr. Moore mentioned, to be used by the private sector and have us return some of the money that was paid for by the taxpayers.

Eventually I see the day when research funds would be larger than they are today, not paid for at taxpayers' expense. But it takes a willingness of the Department and the people who have worked with the Department such as the Auditor General and those folks, to get together and design the mechanism.

How can we do it so it is not front-loaded and discourages people from coming to the labs? The problem with Mr. Rohrabacher's example of the pharmaceutical company and fixing their prices, if you did that once, no one would come back.

Who wants to come to the Federal Government to have their prices fixed? We have a tremendous capability in our laboratories, and we can share them with people who want to bring products from let's say the defense side out into the public sector. We have got to find that mechanism and do it.

So let me ask Mr. Li just to start it. You had some ideas for flexibility.

Would it scare you to have a research account in the Department of Energy, and the more money that Oak Ridge puts in, the more they would get back? Would that bother you?

Mr. LI. Well, I need to explain from the standpoint that I can see some advantages and some disadvantages from having such a fund. Let me see if I can explain it from this perspective.

Some of the programs that are under recoupment provisions right now are, in essence, being terminated at the end of their phases. Some may argue that if you send the money back from the recoupment provisions, that it would no longer go to a program that exists—for example, the Clean Coal Technology.

So that would be an issue.

Another issue would be that the government, in deference to the Congress, would be the one to make those decisions as to whether or not that money should go back to the research community, or whether or not there are other priorities throughout the government that need those particular funds.

Mr. BAKER of California. That takes away the incentive.

Mr. LI. I understand that.

Mr. BAKER of California. And this President and the last President both had gas taxes for deficit reduction. I mean, all you have to do is drive in D.C. to know what the condition of the road is. You do not have user fees to pay off a deficit; you have user fees to build roads.

So there was no incentive for anybody to go out and really work on collecting gas taxes if it does not come back to the product.

I do not think we can support the government on research. There would be no incentive for anybody to cooperate and go out and market products and do the things they have to do.

Mr. LI. I was going to provide you an example to support your position, your point. We recently testified on fees that concessionaires get from land management agencies. We found that in the cases where a substantial amount of those fees went back to the agencies, that the rate of return was actually greater than those instances where they did not.

So I understand what you are saying in terms of the incentives. We have found that to be true.

Mr. BAKER of California. I do feel, though, that the Congress or someone has to maintain control over the budget process. So I think it would be an account within the Department of Energy that would still have to go through the budget process.

In your coal example, if it is a regular function and we have set it up so that we would get recoupment for the Clean Coal Program that could go back, also.

I do not think there is anything wrong with a percentage in that account going back to the program where it came from.

Mr. Lewis, can you think of anything wrong with having incentives for research?

Mr. LEWIS. None whatsoever. And in our written testimony we expressed a concern that the issue of fees coming back in would, unless there are statutory changes, go back into the Treasury.

We were not sure that the added administrative costs of DOE monitoring, you know, for in some cases 20 years, a small business that may not have received a federal dollar but did participate in a CRADA, that that would increase our costs. And it might have a return to the Treasury which may or may not be equal or greater to our costs but would not return to the Department or a mission function.

So we saw that as a net reduction of our buying power as an R&D agency based upon an existing statute.

So we do not necessarily object in theory to Congressional improvements. We want to work with you on that. We do point out that it would be easier if we had the type of change that you propose.

There also I think needs to be kind of a compact that if we do get funds back, that they somehow are not then decremented on the annual appropriations side.

Or, otherwise you take away the incentive—you know, you can't give on one hand and take away on the other. So there perhaps needs to be some sort of process whereby priorities that are meritorious, but not at the funding level, somehow get rewarded or picked from this additionally rather than somehow blending, and we still get X number of dollars in total, but some percent of it is from the incentive fund that somehow then does not add to our buying power.

Mr. BAKER of California. I understand.

We have been reducing the expenditure.

One last question, Mr. Chairman. I know my time is up. Mr. Friedman, do you see any problem with offering incentives for research?

Mr. FRIEDMAN. Mr. Baker, we have not specifically looked at that from an audit perspective, but I will tell you I do not believe we have a problem.

Sometimes in the Inspector General community we are the fairly traditional—we are traditionalists, in many respects. I think there are a number of issues which would have to be resolved, some of which would be discussed by the prior speakers, before we could endorse it specifically, but I see no fundamental problem with it.

Mr. BAKER of California. And there is nothing wrong with backloading it if a product becomes marketable—we get a licensing commission or a fee?

Mr. FRIEDMAN. No. As a matter of fact, the whole principal behind the recoupment in the Clean Coal Technology Program is based on successful commercialization, which implies and one could infer means once sales have been made.

So I have no problem with that.

Mr. BAKER of California. My hesitation with front-loaded fees is you discourage research. If somebody wants to have a whiz-bang machine that will cure cataracts in the eyes using LASER technology, we want them to come in and try.

If it fails, society is not better off, and no one is better off, but at least we have tried. And if we charge fees to everybody that comes in, a static—and I think it was Mr. Li that mentioned the flexibility aspect—if we charge everybody 50 percent, by God they are coming in here and using our facilities and we want X number of bucks, we will discourage research that can lead to great breakthroughs in medicine.

So I am trying to put the flexibility in here, and at the same time give incentives so that that laboratory A will go out and actually hustle people. I can see business parks being set up around laboratories where high-tech firms would come in to use, in the case of Livermore, laser facilities.

So that is what I am getting at, the incentive to market these.

Mr. ROHRABACHER. The devil absolutely could be in the details. In your testimony you mentioned about the exclusion of certain areas that we did not have to count towards reimbursement——

Mr. FRIEDMAN. Right.

Mr. ROHRABACHER. And that in itself made a mockery of the whole concept and did not make it a profitable venture, and probably took it into the area that Mr. Lewis was talking about that it became so complicated it was not even profitable to do after so much of that complication.

Mr. Foley, would you like to proceed?

Mr. FOLEY. Thank you, Mr. Chairman.

These questions are for the Inspector General. We talked last week about the Advanced Lighwater Reactor, and we tried to eliminate its funding on the Floor. We were successful the year before in eliminating the Gas Turbine Reactor.

But during those discussions in the debate, there were a number of issues raised regarding the contracts that were negotiated.

I understand the terms of the Cooperative Agreement between DOE and the Advanced Reactor Corporation. DOE is entitled to recover program costs from the royalties of Advanced Lighwater Reactors sold even if the program is terminated ahead of schedule.

In fact, I understand language from the contract to specifically read:

"If the Cooperative Agreement is terminated, this recoupment agreement shall become effective on the date the Cooperative Agreement is terminated."

My question is: Based on your knowledge of the Cooperative Agreement, is this an accurate perception?

Also, I would like to have provided for the Subcommittee and my office details and the language supporting it on the document.

Are you prepared to answer that?

Mr. FRIEDMAN. Mr. Foley, regretfully I am not prepared to answer it. I am not sure I have those details, but we will scour our records and if we have anything that can be helpful, we will submit it to you.

Mr. FOLEY. Okay. Secondly, the Cooperative Agreement between Advanced Reactor Corporation and the DOE reportedly contains several loopholes that ultimately may jeopardize any recoupment of cost.

Specifically there are limitations as to when royalties can be collected and which utilities are exempt from paying them.

Worse still, there is a clause allowing the Secretary of Energy at her discretion to waive all recoupment costs to protect the economic competitiveness of the reactor vendors.

So as I understand the agreement, there are no guarantees that taxpayers will ever recover a single dollar.

Are these clauses, in fact, in the agreement? And is my impression accurate?

Mr. FRIEDMAN. Well I can speak in generic terms, Mr. Foley. I cannot give you the specific details of that Agreement. I do not have them on instant recall.

Essentially you are raising issues which confirm the issues raised in our report, which says there are enough exemptions built into these Agreements both in terms of the overall model and the specific agreements to effectively make it almost virtually impossible for the Department and the taxpayers to recoupment their investment in these projects.

Mr. FOLEY. Okay. One of the things I am going to want to pursue—and I hope we can have some assistance on—is the fact that all these contracts give tremendous penalties to the government for cancellation.

They all speak to "termination costs," "termination agreements." On the Floor I was told, "Oh, if we stop this project we are committing $44 million this year; but if we stop, it will be like $80 million because we will have to pay all these cancellations."

Then all this conversation comes up about look at all the money we are going to make when we start selling reactors.

One of the Members said, "Boy, we just got $3 million for selling a reactor in China or somewhere."

Well, I look at our costs to date. We have spent, the Federal Government, $398 million on reactor science. So at that rate, I am going to have to sell 120 reactors around the world to even recoup my investment. So it sounds like it is a bad deal for the taxpayers.

But what I resent more is the fact that we have these recoupment opportunities that we talk about so grandly when we start these missions—oh, look at all the money the Federal Government can make. Yet, the loopholes are consistent throughout them, obviating any type of real, solid Agreement.

However, if we choose that we went down a blind alley with these people and want to terminate the Agreement, forget the taxpayers. We are going to write checks till we are in red ink, and that to me is the inconsistencies.

Because in the private sector in real estate transactions, if I err or do wrong, I will be held accountable. If I fail to close, there will be a lawsuit on that failure to close the transaction if I do not have proper reasoning.

But at the same time, I have opportunities from my side. It is a dual-edged sword. You have balance in the contracts. It seems like the Federal Government and all agencies is the sucker.

We sign these Agreements. We give away all the rights, titles, and future benefits, future income streams, future opportunities in the name of science, but we all get run over by the bulldozer when we try and stop it when we find out we have failed, or gone in the wrong direction, or nobody is buying these advanced lightwater reactors.

The thing that kills me is, they were telling me I had to spend these millions of dollars to Westinghouse and General Electric, and their own executive says we are not going to build any.

They are not competitive.

They are not practical.

We are not going to do them.

Yet, now we are saying it is for jobs because we are going to help Taiwan, China, build reactors? So I guess my statement today is clearly that I need the Inspector General's office and others to start looking at contract law, to look at where the Government gets itself involved in these Agreements so we can stop looking like the suckers that just rolled into town on a wagon.

The Federal Government should now start acting like a business corporation that we are, obligating our resources, tax dollars, to things that are probably way over our head, and these large corporations that have multi-million dollar payrolls to have lawyers on staff constantly to negotiate agreements are taking us for a ride.

This is the Bonfire of the Vanity, Part 2, and I just hope we can all work on trying to stress the need for balance in contracts.

I yield back.

Mr. ROHRABACHER. This just reminds me of another story, but I think I will hold off on my story until later on.

[Laughter.]

Mr. ROHRABACHER. Mr. Olver, you may proceed.

Mr. OLVER. What was the story?

[Laughter.]

Mr. OLVER. Thank you, Mr. Chairman.

I have come in a bit late and therefore have missed hearing the individual testimony by the panelists. I wonder, Mr. Henson, if I could ask you:

You are now involved in the forestry and paper business as CEO of a trade association, I guess. It was in a previous life that you dealt as Deputy Secretary of Energy.

In your present life, do you have within the Forest and Paper Association programs that are involved with the Department of Energy in any of these areas of either basic or applied research that would be directly related to the DOE's programs?

Mr. MOORE. Congressman, there was one that was announced and set up before my coming to this organization called "The Agenda 20/20 Program." It is still being fleshed out, but it was signed between executives of my industry and the current Secretary of Energy.

That program is, as I say, still being fleshed out. No money has been spent yet, but it does envision cost-sharing. It does envision, I would hope, recoupment. And it envisions things such as new environmental technologies in the operation of paper mills and things of that nature.

Mr. OLVER. And which one of the categories of the Department's programs would that be in? Would that be in renewable energy? Or environmental management? Or what?

I am trying to relate what is going on here a little bit to the report from the GAO that Mr. Li has been involved in. But that is not up and going yet?

Mr. MOORE. It is not up and going in terms of money being spent yet. They are still fleshing out——

Mr. OLVER. What was the anticipation of money involved there?

Mr. MOORE. There is some. I think the Department of Energy does intend to spend some money on this program. Certainly private industry does, with or without the Department.

Mr. OLVER. Clearly applied. Clearly applied in nature?

Mr. MOORE. I am not sure of that. I don't think anybody knows yet. They have not really specified what the level of research is going to be and the kind of research.

Mr. OLVER. Would you see that I get some information, not a lot, but some executive summary level information about that, at least, program? I would like to see how it fits into what the Department is doing—because it sounds as if it would be under some stress, under some risk, at risk in the policy movements going on now, would be my guess.

Mr. MOORE. If it is, so be it.

Mr. OLVER. Okay. Well, fine. I would like to know what it is. If you knew more about it, I would be asking you how serious the loss of it is, but your comment of "so be it" suggests that at least you do not think it would be a terrible loss.

Let me go over to Mr. Henson for just a moment—excuse me, to Mr. Li for a moment. I have been trying to follow through the programs that you looked at in your study.

Clearly the ones involving Clean Coal, I can find those. It would appear they are part of a group of items in the coal and special fossil energy, I guess, in the fossil energy program.

Mr. LI. Yes, sir.

Mr. OLVER. It is in that Clean Coal group that you indicate that 90 percent of the possible money returned could come—I think I am reading this correctly, that the total amount that has come back thus far is $377,000 from a total expenditure—it is hard for me to tell how much has actually been spent and how much is planned to be spent; how much has been spent thus far——

Mr. LI. That is fair.

Mr. OLVER. But of the planned to be expended of something like $5.5 billion in the coal programs, that $377,000 has come back so far.

How much as been spent thus far?

Mr. LI. Okay. Let me see if I can clear up the numbers. The total amount of the Clean Coal Technology Program itself, right now, that they have planned is about $2.2 billion.

When we talk about the $377,000, and in my statement today it is $379,000 because after the report was issued we got some updates of some numbers, an extra $2,000 came back.

But that $377,000 relates to $36.2 million worth of projects.

Mr. OLVER. Yes, but there must be many other projects that have already been expended. It is only on the $36.2 million that that amount has come back out of what would be, over time, an expectation of $2 billion to be subject to recoupment.

Mr. LI. In our study, we did not—in working with DOE, we did not identify the exact amount that has been spent to date. What we tried to relate was how much has come in, and what does that relate to in terms of the projects?

As I was saying, the $377,000 relates to the $36.2 million.

Mr. OLVER. Okay. I think what is happening here is that I cannot work through these numbers as fast as I need to and keep them sorted.

Mr. FRIEDMAN. I can provide you some information, Mr. Olver. The Congress has appropriated about $2.5 billion for this program. $1.1 billion is the actual expenditure to date. That is the latest number we have.

Mr. OLVER. In contracts on the coal and special technology side?

Mr. FRIEDMAN. $1.1 billion on the Clean Coal Technology Program in its entirety. That is the best information I have.

Mr. OLVER. Okay, well, I may be—In your study, Mr. Li, you have looked at four offices within the Department——

Mr. LI. That is correct.

Mr. OLVER. And then separate programs within those offices.

Mr. LI. Yes, sir.

Mr. OLVER. Now in the case of the nuclear energy one, the Advanced Lighwater Reactor is the whole program. In all the others, I think there are a variety of programs?

Mr. LI. That is correct.

Mr. OLVER. Are the programs in each of the different offices? Where would the Metals Initiative be? Which one of the offices would the Metals Initiative be a part of?

Mr. LI. The Metals Initiative is in the Energy Efficiency and Renewable Energy.

Mr. OLVER. In Energy Efficiency.

Then where would the Electric Vehicle Advanced Battery Development be?

Mr. LI. That is also in the same one.

Mr. OLVER. In the Energy Efficiency.

Mr. LI. That is correct.

Mr. OLVER. So that would mean, then, that you have not looked at anything in the environmental management area? That is not one in which you——

Mr. LI. That was one of the offices we looked at——

Mr. OLVER. But you did not look at any specific program within it?

Mr. LI. Currently they do not have any that relate to recoupment.

Mr. OLVER. Okay. On the ALWR, how much have we recouped there of the expenditure that has been made?

Mr. LI. Zero.

Mr. OLVER. Nothing has been recouped there.

Mr. LI. That is correct.

Mr. ROHRABACHER. The gentleman will have to wind it up.

Mr. OLVER. Fine. Thank you.

Mr. ROHRABACHER. Mr. McHale?

Mr. MCHALE. Thank you, Mr. Chairman.

My questions will relate also to Clean Coal technology and for the most part they will be addressed to Mr. Moore, although I invite a response from any other witness who would like to make a comment.

I have a major international corporation in my District that has actively participated in Clean Coal technology, so my interest is parochial as well as broad based in terms of public policy.

The questions, Mr. Moore, really fall into two categories. The first category has to do with the general concept of recoupment and how that is received by the private sector.

To what extent, if at all, does the initiation of a recoupment policy serve as a disincentive for private corporations to participate in these kinds of programs?

That is kind of a broad brush question. It is specifically in the context of Clean Coal technology, but it has come up previously in other discussions involving R&D going far beyond Clean Coal technology.

The second question is more specific.

On page 3 of your testimony your indicate, and I quote:

"My further investigation of the broader issue of taxpayer return on R&D investment exposed what I considered a casual treatment of statutory provisions for recoupment of Federal investment in the Clean Coal Technology Program."

I have read your testimony, and I have scanned the GAO report, and I would appreciate it if you could flesh out in greater detail what you mean by "casual treatment of statutory provisions for recoupment" and whose "casual treatment" was it?

Are we talking about employees of the Federal Government who did not accept that statutory responsibility as seriously as they might?

Or was it a casual treatment in the private sector in terms of obedience to the law?

Mr. MOORE. Congressman, on the first question of is it a disincentive, if you talk to the people who administer the programs at DOE, if you talk to the private sector, who want to participate in the program, they both will tell you it is a disincentive. At least that was what I ran into when I was overseeing the programs.

Mr. MCHALE. How serious are the disincentives?

Mr. MOORE. I do not think it was serious at all.

It was serious, in this sense, that as long as you do not have a standard operating procedure, as long as you do not know how to do this quickly and efficiently like a businessman normally does business, he thinks doing business with the government is going to cause him to drag out for years under the contracts, and therefore they could be a disincentive and a real one if the government does not do its work expeditiously in a more businesslike manner.

If you do it right like the private sector does it, it is not a disincentive to somebody who genuinely is willing to not get something for nothing, and to pay back the government the money that it gets when it makes their program commercial and makes money on it.

Mr. MCHALE. Assuming you do it right. Let's say we reform the system and we do it right, can we overcome the perception problem within the private sector; that there is a continuing difficulty that the disincentive will disappear along with better practices?

Mr. MOORE. In time, you can. It will take time. Businessmen are very suspicious of doing business with the government. They are very suspicious of the red tape and all the time it takes.

So you are changing culture both within the Department of Energy to really do this right, and within the business community to want to do business with the Federal Government.

Mr. MCHALE. Well, that is my worry, that we will chase away exactly the folks that we want to bring into the system in the private sector for fear on their part that we have not gotten our act together, and that they may not recognize the improvements and efficiencies that we hope to achieve.

Really, there are two steps here. One, you have got to get it right.

And, two, you have to convince the private sector that you have it right so that they are willing to participate.

If you fail at either level, you end up I think having failed to achieve the goal of an active partnership and active participation between the public and private sectors.

Mr. MOORE. Congressman, I agree with you, but I do not think failure is an option.

Mr. MCHALE. Okay.

Mr. MOORE. I think this can be done, and will be done if this Committee and other enlightened people in the Department continue to press forward to make it work.

Mr. MCHALE. My second and final question, the one I stated earlier with regard to the casual treatment. What really did you mean by that?

Mr. MOORE. The comment was meant towards the people who ran the program within the Department of Energy, not towards the business.

Well, it was a three-part comment.

The Appropriations Committee did not particularly want to see us get tough on that. They called me. I had calls from Members of the Appropriations Committee. What are you doing tightening up on this recoupment, or cost sharing on clean coal technology?

You are going to run people off.

That sort of thing.

We also had the problem with the administrators within DOE being casual, meaning they had not really had any teeth in it before and sort of got along without doing it, and were really primarily interested in getting the money out into the hands of people who were going to develop clean coal technology.

That was their priority, not getting the money back. So they looked at this as being something that they would just give a slight brush of attention to and were casual about it.

The people receiving the money had never really been pressed in prior rounds to have to really get tough on paying it back, and so they were casual, too.

But I would say what I really meant there by that comment was the administrators within DOE.

Mr. MCHALE. In short, to the extent that there was irresponsibility, it was primarily in the public not the private sector?

Mr. MOORE. I would not go so far as to say it was irresponsibility, because nobody really explained to them, we are serious about getting this done.

We did, and they got serious, and I think Mr. Li is indicating that is where the $400,000 has come from. When we began to tight up, the staff carried through.

The Department of Energy, the private sector signed on, the Congress groused but willingly let us go forward, and it got done.

Mr. MCHALE. Thank you, Mr. Chairman.

Mr. ROHRABACHER. I would like to thank this panel of witnesses.

Yes, Mr. Baker.

Mr. BAKER of California. I would like to ask one follow-up question, to reassure Mr. McHale.

If we had a research account where the laboratories participated, there would be an incentive for them to get out and hustle the clients.

There would also be an incentive for the CRADA process to be sped up. Part of the problem was they would wait a year to get their approval through the Department and back out again.

My question is to the much-maligned lightwater reactor. If we had an incentive licensing program, and Westinghouse and the government wanted to continue research in lightwater, and then Taiwan wanted to buy one because politically you could not put a nuclear reactor in America but Taiwan would want one, and we had a licensing agreement, what would be wrong with our selling the plant to them and having them make clean fuel, and then us recouping our plans?

Mr. Li, can you think of anything wrong with that, if other people were still chasing this technology?

Mr. LI. No, I do not. The Clean Coal Technology Program is the only one that actually took out the foreign sales requirement. All the other programs that are in recoupment right now still allow the foreign sales to be included.

So in this particular case, while the money has not come back yet, if indeed the sale does go through to Taiwan, I would expect some of the proceeds to come back in terms of the recoupment requirements.

Mr. BAKER of California. So just because we have a mechanism that would cover proceeds does not mean we would alter our approval process for projects?

I mean, the people would be less likely to chase bad projects rather than more likely.

Thank you, Mr. Chairman.

Mr. ROHRABACHER. All right. I want to thank this panel. I would again just note that we are examining this issue today to try to move forward with some legislation that will deal with this issue.

Mr. Moore has tried to deal with it before, and I have had some skepticism already from some senior members, but we are going to try to do what is right around here and maybe we will get something done.

I will tell you one thing. If you are deterred from trying, you certainly will not get anything done. So we are going to move forward on this and thank you very much for your contribution today.

We will be calling on you for advice in the future.

[First panel excused.]

Mr. ROHRABACHER. We have a second panel.

As the second panel is being seated, I would like to note that Mr. Richard Wilkey, the President of Fisher-Barton, Incorporated, agreed to testify today on his technology partnership project with Sandia Labs, but urgent business made it impossible for him to be at this hearing.

Without objection, his written testimony will be submitted for the record.

So we have three witnesses for the second panel.

Our second panel consists of those on the front line of technology partnerships at our National Labs. Dr. Daniel Hartley, Vice President for Technology and Development at Sandia; and we have a special word that Mr. Baker would like to throw in.

Mr. BAKER of California. I would like to take this moment to introduce Dr. Ron Cochran who has worked with the Department of Energy within the Department, and then out in the field at the laboratories.

When I was first selected, it was Ron's cumbersome job to break me in and to train me and teach this nonscientific brain a little bit about what is going on at the laboratories.

I want to publicly commend him for the fine way that he works the Lab as executive officer. We have even changed the officer at the Lab since he has been there, and things are running very smoothly.

They have also gone through downsizing several times, and that is a very pleasant procedure in an area that used to grow unrelentlessly.

So the last several years have not been as pleasant at the Lab as they might have been, and Ron has done a tremendous job and I want to publicly appreciate his bringing me on board.

Mr. ROHRABACHER. Congressman Baker is as aggressive a Congressman in support of your Lab as any Congressman I have seen in support of any project in his District. So you have got an asset there, as well.

Mr. BAKER of California. I want to also thank the Subcommittee Chair for coming out and viewing the Lab. We had a tremendous hearing with Mr. Rohrabacher and Mr. Walker——

Mr. ROHRABACHER. It shows you how aggressive he is.

[Laughter.]

Mr. BAKER of California. He does not do plant tours in his own District, so why would he do one in mine; but thank you very much, Mr. Chairman.

Mr. ROHRABACHER. Okay.

And, Dr. Charles Gay serves as Director of the National Renewable Energy Laboratory.

First of all, Dr. Bartley—Hartley. Pardon me.

STATEMENT OF DR. DANIEL HARTLEY, VICE PRESIDENT FOR LABORATORY DEVELOPMENT, SANDIA NATIONAL LABORATORY

Dr. HARTLEY. Thank you, Mr. Rohrabacher, Mr. Baker. It has been a pleasure for me to serve 28 years of my career working in a National Laboratory. Virtually all of that 28 years was involved in energy and environmental areas.

I think I have lived through every possible version of a cooperative agreement with industry or universities that you could dream up.

It has been a very fulfilling experience——

Mr. ROHRABACHER. We will see if we can find a new one for you.

Dr. HARTLEY. Yes, I think you probably will come up with a few new ones.

[Laughter.]

Dr. HARTLEY. Currently my job at Sandia is to look at our future, and our future is a difficult one as you know. The key to that success in the future is partnerships.

Partnerships I believe require incentives. I want to discuss and encourage thought about that.

I also want to add that we still have a job to do. The work of the Labs is not done by any means. We want to do our mission effectively. We are not interested in just doing a whole collection of odd jobs. We have a critical and important mission to accomplish, and we want to do that, and we want partners to help others achieve that.

The outline of this meeting discussed a number of possible ways of saving money for the Labs, saving money for the government, and many of those are useful. But I do want to add the macro economic aspect of this because we tend to forget it sometimes, and yet that adds a much more substantial return to the government and to the taxpayer than we can ever achieve through licensing and recoupment. And I will add a little bit to that.

I do believe that it would be counterproductive to institute any sort of across-the-board repayment policy that would discourage companies from working with the Labs.

We need a level playing field for our U.S. industry to work in their global businesses. On the other hand, I believe there are areas where it is appropriate to recoup costs. In my opinion, that is in the developmental or demonstration area where the government is investing money to reduce risk for industry where the technology has already been decided upon and recouping there is appropriate.

Clean coal technology, I think, is an example of that.

But where it becomes the application or development of new technology where many share in the results, the issue of recoupment is a different one, and perhaps licensing is the most businesslike way to achieve that.

Cost-sharing has been very successful for us for many years. It is important because generally the projects are of interest to both the government and industry.

Secondly, the work has been very generic. And finally, the government has achieved substantial benefit—and I will give you a couple of examples.

I do want to say a couple of words about CRADAs, as well. They have been very useful for us. In fact, I think CRADAs have been the cause of a cultural change in America.

In my years in the laboratory, we have had Japanese visitors, European visitors for decades, and it was not until the CRADA business began that we started getting a flood of industry visitors from the U.S.

We have nearly 250 CRADAs. They are all with U.S. industry. We are now working heavily with U.S. industry, and much less so with foreign industry. I think that is just the way it ought to be.

We do CRADAs with big businesses and small businesses, and most of those CRADAs have led to licensing agreements on technology which have resulted in return to the Labs and return to the government.

We have a goal at Sandia of significantly increasing our licensing and intellectual property returns. This year we expect to get $800,000, which by the way compared to the recoupment for the clean coal technology is about twice—and this is just based on our licensing programs at one laboratory.

We expect that to double next year, and double the year after that. But we expect it to top out at around $50- or $60 million. That is a significant amount of money, but it is a very small part of a $1 billion laboratory. It will never be a major source of income to us.

I think you need to keep it in that perspective.

However, I really believe the major return is macro economic. If you consider that that royalty income reflects an enormous increase in sales by those companies of new technology-driven products, you realize that that is creating jobs in American industry.

It is creating tax revenue to the government.

It is creating income for other real people—entrepreneurs, industry workers, investors and the like. And I think that is American business at its best.

I would like to just finish with a couple of examples that I think are appropriate. I am sorry Mr. Wilkey was not here to talk about the Fisher-Barton activity. We had a very interesting CRADA with Fisher-Barton. I will not go into the details, but we had a detailed analysis done by the University of New Mexico on the overall economic impact of that study, that activity.

The government invested $57,000. We had a 300-to-1 return on that investment to the taxpayer. That is a marvelous example of a CRADA gone right.

We have a wonderful series of CRADAs with Goodyear. Goodyear is using our technology; we are using their technology to design nuclear weapons.

We managed to find a situation, as their Vice President for Research says, Nissam Caulderone, he told me they had a job to do that required A + B. We had a job to do that required A + C. So we did A together, and we both benefitted at half the cost. I think that is another terrific example.

My last example is in microelectronics, something very important to the weapons' business and very important to Sandia.

We have a program going with the semiconductor industry involving Sandia, Lawrence Livermore, and Lawrence Berkeley Laboratory where we are providing critical technology to that industry to get them into the next century.

They claim this will get them to their roadmap goals in the year 2002 and they are willing to pay, and they are going to pay up to

$100 million for the development and application of that technology.

We benefit not only from that financial income but the technologies are technology that we are very interested in for our mission requirements and it is very important to us.

So in the end, let me just summarize by saying that of the methods of recouping costs, quite honestly the licensing approach is very sensible and is very businesslike and it works just fine, but it is not going to offset the cost of the lab significantly.

I do not believe we need an across-the-board policy for repayment. I think it needs to be done very carefully. I do not like to discourage these partnerships. They are critical to the future of the labs.

Quite honestly, I believe that are critical to the future of the country.

My most important consideration is that we need to fashion incentives, not disincentives, for these partnerships so they can compete in a global market, and that the labs can achieve their mission at an effective and affordable cost.

Thank you.

[The prepared statement of Dr. Hartley follows:]

STATEMENT OF DR. DANNY L. HARTLEY, VICE PRESIDENT, LABORATORY DEVELOPMENT DIVISION

SANDIA NATIONAL LABORATORIES

BEFORE THE UNITED STATES HOUSE OF REPRESENTATIVES

COMMITTEE ON SCIENCE

SUBCOMMITTEE ON ENERGY AND ENVIRONMENT

AUGUST 1, 1996

INTRODUCTION

Mr. Chairman and distinguished members of the subcommittee, I am Dan Hartley, Vice President for Laboratory Development at Sandia National Laboratories. Sandia is managed and operated for the Department of Energy (DOE) by a subsidiary of Lockheed Martin Corporation. We perform scientific and engineering research and technology development in support of DOE's missions in nuclear weapons and arms control, energy, environment, and the basic sciences.

I welcome this opportunity to share with you my views on how DOE can recover or reduce some of its R&D expenditures through cost-sharing, licensing, and other arrangements. For more than twenty years I managed Sandia's energy and environmental programs, and during that time I became familiar with numerous cost-shared programs with industry. In my current position, I have general responsibility for Sandia's technology transfer programs, including the administration of cooperative research and development agreements (CRADAs) and the licensing of intellectual property. I believe my background and experience are very relevant to the issue under discussion today.

The nation's investment in the Defense Programs laboratories of the Department of Energy has paid many dividends over the years, not the least of which has been deterrence of major war. This investment will continue to pay dividends in international peace as we maintain a credible nuclear deterrent and develop technologies that support arms control agreements and programs in nonproliferation and counter-terrorism. We should not lose sight of the ongoing relevance of these primary mission activities. In addition, it has become clear that the laboratory investment can provide an additional return to the nation through appropriate contributions to technology development with commercial potential and strategic economic importance.

The charter for this hearing identified the following methods currently used by DOE and its laboratories to reduce R&D expenditures: (1) sharing costs with non-federal partners through contracts and consortia; (2) requiring repayment of the federal government's investment in cost-shared technology development that is commercialized; (3) cooperative research and development agreements (CRADAs); and (4) licensing agreements. While these methods are useful, I would like to point out that the macroeconomic benefit of federal investment in cooperative R&D with industry constitutes a much more substantial return to the government and taxpayer than can be achieved through licensing and recoupment provisions. It would be counter-productive to institute an across-the-board repayment policy that might discourage companies and consortia from seeking arrangements with government-owned laboratories for joint development of new technologies and markets.

COST-SHARING WITH NON-FEDERAL PARTNERS

The DOE laboratories and industry have worked closely together on energy supply and conversion technologies since the Energy Reorganization Act of 1974 permitted such collaboration. In light of the energy crisis at that time, cooperation in this arena was regarded as serving an important public purpose that was of shared concern to both industry and government. This continues to be an important model for collaborative R&D. Industry and the DOE laboratories fund and perform mutually supportive research in application areas that serve important public needs.

This model does more than simply reduce DOE's cost of research and development. It would be foolish for government-owned laboratories to attempt to solve these public interest problems in isolation from industry, even if they had sufficient funds to emulate the private investment. We have learned that industry must take the lead in such programs. Government can help moderate the inherent long-term technical and financial risks which otherwise might deter industry from undertaking new technology development of public importance.

Historically, most cost-shared R&D arrangements have not required that industry repay the federal government for its investment. There are good reasons why this is the case. First, it is understood that these projects are in the interest of both government and industry. Often, an important public purpose is served by the work. In addition, the government frequently derives substantial benefits in terms of access to critical technologies and competencies for government missions.

For example, SEMATECH, the semiconductor industry research consortium, received federal matching funds for several years because it was felt that the viability of this industry was a national security issue. Sandia's collaboration with SEMATECH has helped support DOE's microelectronics capability for radiation-hardened microelectronics for nuclear weapons. We have been able to leverage our DOE funding through this and other partnerships to acquire advanced equipment and process knowledge that could not have been developed without large increases in our direct budget.

Another reason why many cost-shared projects are not suitable for cost-repayment requirements is that the work is often too generic for it to be clearly associated with a prospective product. A research concept may take years of additional development by industry to reach the market, and the relative value of the DOE contribution to a product may be difficult or impossible to quantify.

REPAYMENT REQUIREMENTS FOR CERTAIN COST-SHARED PROGRAMS

In accordance with the guidance of the Energy Policy Act of 1992, some cost-shared R&D agreements contain provisions that require repayment of the government's expenses if a technology resulting from the joint work is later commercialized. At Sandia, we participate in three of these programs: Clean Coal Technology, Electric Vehicles Advanced Battery Development, and Advanced Light Water Reactor. Each of these efforts is aimed at demonstrating hardware or process concepts with commercial potential for specific applications. They are not engaged in fundamental or exploratory research.

The federal government will receive a portion of the royalty streams from licensing of patents waived by the government and owned by the participating firms. However, the repayment terms typically contain significant qualifications, such as limited payment periods, exclusions from the investment base and revenue stream, and waivers, so that actual repayment proceeds may be rather small. For example, the Clean Coal Program represents a federal investment of $6.5 billion since 1985, of which about one-third is subject to repayment. Less than half a million dollars have been repaid to date. The Electric Vehicles Advanced Battery Development Program has similar limitations and exclusions on repayment.

Such highly conditional terms may seem overly generous, but they reflect the government's awareness of the important public interest served by these programs and the great technical and financial risks assumed by the companies in taking development all the way to market. Industrial consortia come to the national laboratories when technical and investment risks are high. If their engagement with the laboratories increases those risks, they won't bother; important alternative technologies won't be explored or developed for commercialization.

COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENTS (CRADAS)

In the years since passage of the National Competitiveness Technology Transfer Act of 1989, the CRADA has proved to be a very useful and flexible mechanism for collaborative R&D that extends DOE's research opportunities. Work under a CRADA is cost-shared, with the industrial partner contributing at least 50 percent of the project cost and sometimes substantially more (up to 100 percent). In the majority of cases, the industrial partner is assessed an additional fee of 28 percent by DOE, although this fee is often waived for small businesses.

Sandia has signed CRADAs with many small businesses. Many of these CRADAs have led to new products and permitted the licensing of technology developed at Sandia for commercial applications. Many CRADAs have also been executed with some of the nation's largest companies. With the Intel Corporation, for example, we have performed 12 CRADAs since 1991 with a total value approaching $30 million. In the last few years we have signed several multiple-partner CRADAs with consortia of companies and universities. Many of these newer CRADAs comprise a substantial segment of a specific industry or involve working with organizations that represent an entire industry.

The strategic purpose of a CRADA is frequently quite different for the industrial partner and the laboratory. For example, the tire industry may seem to have little in common with DOE missions. But in fact, tire designers and component designers for nuclear weapons can sometimes face similar problems. Sandia has collaborated with Goodyear Tire and Rubber Company through a CRADA on a design capability of mutual interest. Together we improved an engineering tool for solving structural mechanics problems common to both tire design and the design of certain nuclear weapon components. The company benefited from access to modeling and simulation codes and experimental techniques developed in the weapons program; DOE benefited from substantial improvements in those codes resulting from the industrial interaction. The improved computer codes will be used to solve weapon component design problems that were previously intractable.

CRADAs frequently support commercial end-use applications that have no apparent utility to any particular DOE program. But it is the science and engineering involved in the performance of a cooperative project—and not its end use—that is the source of relevance to DOE. This strategy has permitted us to leverage diminishing DOE resources and help maintain and enhance our core technical capabilities.

LICENSNG OF INTELLECTUAL PROPERTY

Access to licenses is an important incentive to participants in CRADAs. Intellectual property resulting from a CRADA can be protected. The National Competitiveness Technology Transfer Act of 1989 made it possible for federal laboratories to license technology to industry and to provide appropriate royalty-based incentives and compensation to inventors and other enabling personnel.

We have a goal to dramatically increase the licensing of intellectual properties developed at Sandia. We want to provide greater licensing opportunities while ensuring that the government shares in any commercial successes through the collection of reasonable royalties and licensing fees. A portion of the monies from the royalty stream is used to reward the inventors of the licensed technologies and to reward other outstanding technical employees whose inventions cannot be commercialized because they are classified. The remainder is distributed to the technical departments of the laboratory for scientific R&D consistent with the mission and objectives of the laboratory. These funds are quite small in comparison with program funding, but they can sometimes be very helpful.

Under the terms of Sandia's management contract, if royalty income exceeds five percent of the laboratory's operating budget in any fiscal year, 75 percent of the excess will be returned to the U.S. Treasury. Revenues from licenses are expected to approach $800,000 this fiscal year, which is double last year's, but they would have to climb to more than $60 million to reach a level at which a direct return would be made to the Treasury. We hope we can eventually reach that level of royalty income, but it will take years to achieve.

Royalty income from licensing has potential for providing a reasonable return on federally owned technologies that have commercial uses. However, I believe it would be a mistake to overstate that potential. In fiscal year 1995, DOE intellectual property generated about $4 million in royalties from all the national laboratories. It is certainly reasonable to expect that amount to increase by ten times over the next few years, and it is perhaps conceivable that revenues could increase by 100 times over the next many years. But that is probably the horizon of reasonable expectations with regard to royalty revenues.

MACROECONOMIC RETURNS ON FEDERAL INVESTMENTS IN COOPERATIVE R&D

Let's assume that $40 million is a reasonable target for aggregate licensing income from the DOE national laboratories by 2000. This amount is trivial with respect to the operating budgets of DOE's laboratories. However, when you consider that it represents a royalty of about five percent of commercial sales by licensees, it begins to take on significance. The $800 million of commercial sales results in profits and income for real people—entrepreneurs, workers, investors. Some of that income is paid in taxes. Some is spent on consumables; and much of it is reinvested, creating new industrial capacity, jobs, and income for others. The multiplier effect of this phenomenon is well known as a powerful stimulus of economic activity.

But is the federal investment that produces those economic benefits reasonable or excessive? Keep in mind that the federal investment in the national laboratories is an established fact. If the laboratories did no licensing at all, they would still have to develop technologies for federal missions—most of the investment would still have to be made. Consequently, it is the marginal investment, not the full-cost investment, that we should consider for this analysis. To answer this question, I would like to cite a real example or two.

Over a twenty-year period, Sandia developed a world-class program to apply very hard surface coatings to parts for nuclear weapons. The technology can also produce coatings for superior commercial products. A small company in Wisconsin, Fisher-Barton, recognized the potential of this process in several new commercial applications and approached Sandia for help. Mr. Wilkey, who is here today from Fisher-Barton, can describe the specifics of the technology transfer process that occurred. Briefly, an analysis of this technology transfer interaction by the University of New Mexico showed that the macroeconomic benefit was close to $25 million. DOE's marginal cost for the assistance was just $57,000. The benefit-to-cost ratio was about 300 to one in this case.[1]

Let's turn to a case involving a large U.S. corporation. Earlier in this statement I referred to Sandia's CRADA with Goodyear Tire and Rubber Company. Engineers at Sandia and Goodyear collaborated to improve a computational engineering tool for solving structural mechanics problems common to both tire design and the design of certain nuclear weapon components. Sandia's marginal investment was negligible because we were already paying the salaries and computer usage costs of the engineers we employ to maintain the weapons-related engineering competency. Moreover, we acquired valuable improvements in our capability from Goodyear's expertise that more than offset our costs.

I cannot produce rigorous numbers for the macroeconomic benefit, but I think you can easily put it into perspective for yourselves with the following information. Consider that Goodyear is the only manufacturer of tires that is U.S.-based and majority-owned by U.S. investors. The company has faced aggressive technical and price competition from foreign manufacturers who are subsidized by their governments. With its healthy volume of international sales, Goodyear measurably improves the U.S. trade deficit, creates U.S. jobs, and generates profits that are taxable here or are reinvested in a U.S.-based enterprise. Sandia has been a factor in enabling Goodyear to confront the foreign competitive threat.

There is also a national security aspect to this story. Tires are an essential defense commodity. Stock production tires are not always appropriate for military needs. Early in the conflict known as Desert Shield/Desert Storm, the services discovered that their tires were wearing out three times faster than usual because of the severe environment. The defense department turned to Goodyear for help, and the company was quickly able to supply non-commercial tires that met the special needs of that situation. This is an excellent example of the strategic importance of a robust industrial capability that can succeed against subsidized foreign competition.

---

[1] Santa Falcone, "Technology Transfer Impact Profiles" (Interim Report #1, Prepared for Sandia National Laboratories, University of New Mexico, 1995).

Another essential industry—perhaps the most essential industry for defense—is microelectronics. For many years, Sandia's California laboratory, together with Lawrence Livermore and Lawrence Berkeley national laboratories, has researched extreme ultraviolet lithography as a technique for fabricating integrated circuits (ICs) with features down to one-tenth micron. It is apparent that ICs of this scale are crucial for meeting the semiconductor industry's road-map goals in 2002; if we don't succeed by then, we may well lose all the business represented by this new generation of ICs to subsidized foreign competitors. We are now negotiating a consortium involving these laboratories, industry, and universities to advance this technology rapidly toward commercial deployment. Industrial partners will include U.S. semiconductor equipment manufacturers and the major U.S.-based companies that use ICs in commercial products. The federal investment in this cost-shared development will be vastly eclipsed by a macroeconomic benefit that could well be in the tens of billions of dollars. In addition, the national laboratories will strengthen their competencies in metrology, x-ray optics, precision manufacturing, laser technologies, and several other areas that are critical to DOE's missions in the long term.

SUMMARY AND CONCLUSION

I have discussed the four methods currently used by DOE and its laboratories to reduce R&D expenditures: (1) sharing costs with non-federal partners through contracts and consortia; (2) requiring repayment of the federal government's investment in cost-shared technology development that is commercialized; (3) cooperative research and development agreements (CRADAs); and (4) licensing agreements. Each of these methods is appropriate under certain conditions. The first, cost-sharing, has a long history of mutually beneficial interactions between government-owned laboratories and industry. The second, required repayment of the federal investment, may be appropriate in those cases where the government waives its claims to intellectual property rights and the repayment terms are structured such that they do not discourage commercialization or jeopardize realization of the public purpose served by the arrangement. CRADAs will continue to be important vehicles for reducing DOE's mission-related R&D costs, particularly since new CRADAs will be funded directly by program managers with program funds.

The most promising of these methods is the last one: licensing of intellectual property by the national laboratories, made possible by technology transfer legislation of the last seven years. The incentives and mechanisms of licensing as established in current law are working well. Licensing programs at the national laboratories are "taking off," and the expectation is for rapid growth during the next few years. While royalty income may never be significant in the context of DOE's total budget, it provides powerful incentives to the laboratories for making technology transfer meet industry's real needs. Moreover, royalty income is an indicator of much larger macroeconomic benefits to the private sector and the national economy.

In my view, there is no need for a DOE-wide policy requiring repayment of the federal investment in successfully commercialized cost-shared technologies. I am concerned that a blanket policy of that nature will be perceived by industry as increasing their contingent liabilities and product development risks. However, it may be appropriate for DOE to require case-by-case consideration of a repayment requirement for those arrangements where DOE will waive intellectual property rights. DOE should have the flexibility to qualify repayment terms as necessary to avoid discouraging further commercial development by industry.

The most important consideration is to fashion incentives that will increase the ultimate macroeconomic benefit of the federal investment in cost-shared R&D with industry. There is nothing wrong with recovering the government's direct investment if a technology is successfully commercialized. But we are beginning to do that very nicely through licensing. Whatever new requirements are proposed should be carefully considered for their potential impact on the incentives for commercial development of new technologies, new markets, and the competitiveness of U.S. industry.

Mr. ROHRABACHER. Thank you very much.

Mr. Cochran—Dr. Cochran?

STATEMENT OF DR. RON COCHRAN, EXECUTIVE OFFICER, LAWRENCE LIVERMORE NATIONAL LABORATORY

Dr. COCHRAN. Thank you very much. I certainly am pleased to appear before you today. I want to thank the Committee for the opportunity to help you as you consider the policies and procedures that we need to try to recoup government investment in R&D.

I have a statement for the record and, with your permission, I would like to submit that.

Mr. ROHRABACHER. Without objection, and we appreciate you summarizing it.

Dr. COCHRAN. Thank you very much.

Now in reflecting on these issues of making R&D funding go as far as possible, and in trying to find ways to fund the DOE programs in a very constrained budget environment, I would like to sort of highlight a few of the following points.

We are very, very sensitive to what Congress wants us to do. We understand the pressures that are coming about to reduce the budgets.

At the same time, we do need to recognize what the DOE laboratories were set up to do and sort of how they are oriented. Principally, that is large-scale, long-term high-risk R&D, and that is something that we are stuck within a sense, but something that we were set up to do and we still need to carry that out.

In the past we have been very much restricted from competing with the private sector. Now what that translated into was something that said to our employees, do not worry about the steps that you need to take to get to the commercialization, focus on sort of the front end, the research part.

Secondly, it also said. Do not even start to focus on things that are just modest extensions of the current technology. Go for the big, high payoff things, the things that are impossible to do.

So that is the kind of organization you have got out there right now. But there are some important exceptions, and I want to give you some examples of those exceptions.

As you can see from my statement, Livermore has been principally focused on national security, and so the opportunities for direct payback there were pretty limited. But with the legislation that you have provided us in recent years, we have been very creative in trying to find new ways to actually increase the amount of payback.

I want to discuss sort of three categories of ways in which the taxpayers benefit from collaboration with industry.

I might just point out that we now are at a level of about 7 percent of our total work involves cost-sharing with industry. So that has been growing over the last few years.

There are sort of three ways to get payback in a sense from industry. One of them is cost avoidance. In an area where we are able to drive the market like supercomputing, like making special LASER glasses and so forth, we are able to get industry to invest a great deal of their money to provide the products that we need to save the government investment to stretch R&D funding.

We have been doing that for decades. It works very well, and we would certainly like to see that encouraged and continue to do that.

You may have seen announcements recently on an accelerated and strategic computing initiative where we are going to buy the world's most powerful computer, and industry is going to spend a lot of money—probably at least as much as we are paying—to help develop that for the industry.

Another area is in laser glass for the Nova laser and hopefully for the National Ignition Facility, where we actually have companies that are going to build facilities, in this case probably in the California area, for making that glass.

We will give them the technology; they will build the facilities and sell it back to us, and we will save a great deal of money.

Now beyond that, there are efforts which we have focused on intensely in recent years to try to have CRADAs and to develop licensing arrangements.

Now those do provide a direct payback to the government. I have got some examples of those where we are getting good payback for those particular items, but they tend to be special cases within overall program work—and I will come back to those.

The third area, which is closer perhaps to the other things you are hearing about today, is areas where we designed a project with payback in mind. We have got an example or two of that which I think will be interesting to you.

Now looking at the licensing, just to give you the context of how difficult that is, we have an average of about 225 significant inventions a year at Livermore. Those are ones that we patent.

Now in the last few years we have been getting 5 or 6 of the R&D 100 Awards. Now those are supposed to be recognition of the most important inventions, the ones that are most likely to have commercial payoff of any in the country.

And of the 60 or so R&D 100 Awards we have gotten over the years, 5 of those have been licensed, and we have 25 licenses coming from those, and that is starting to return about a million dollars a year in revenue back to the laboratory.

So there is a pretty strong winnowing out process between good inventions and something that will actually pay back.

The ones that do pay back can pay back very well, and that is what we want to go for, I think.

I have got a few examples there. We mentioned one, which is the extreme ultraviolet lithography where the industry is going to basically make a major investment building on the CRADA investment that we have, the licensing fees coming back from that will probably be quite substantial.

We have got another where we have a very small technology called micropower impulse radar, which is a spinoff of our laser programs. It basically is an inexpensive radar system which has many applications.

Now it turns out that this one invention, which we invested probably a couple million dollars in incrementally, is providing about a third of the total licensing fees and royalties of all laboratories within the Department of Energy, this one invention.

Mr. ROHRABACHER. Do you have the patent for this?

Dr. COCHRAN. Yes, sir. We have patents in every way we can think of.

Mr. ROHRABACHER. I believe in a very strong patent system.

Dr. COCHRAN. Very strong.

We have sold 16 licenses already. We have got 4000 inquiries, and we have probably got another couple hundred to go. And so that one, which is very much an exception, is going to provide significant royalties for far more than the initial incremental investment in government funds. But that is a very special case, and most of them do not pay much.

Mr. ROHRABACHER. Could you summarize now and then we will move on to Mr. Gay and then we will come back with some questions. I have some questions specifically about that project, in fact.

Dr. COCHRAN. Okay. I will mention one other where a project was designed to actually pay back the government. That was the Atomic Vapor Laser Isotope Separation Project. That has have a $1.4 billion investment over 20 years.

That was intended to basically provide a payback to the government through selling enriched uranium for commercial power plants.

Congress has decided to privatize that, so the government will still get its investment back when that activity goes private.

I guess there are three things that we would like to see happen. One is to continue to emphasize the cooperation to reduce program costs. That is very, very important, and whatever we can do to simplify that would be worthwhile.

We would like to see an increased emphasis on licensing and starting to try to build the kind of research account that Congressman Baker was talking about.

There are limits on how much labs of our type can do there, but it is a very, very good idea to push that just as far as we reasonably can.

Then the third area is. If we want to design projects that are focused really on payback, that can be done and it can be done very successfully, but we almost have to design that in from the front end and not try to switch it around later on.

We have got examples of successful projects of that type.

Thank you, very much.

[The prepared statement of Dr. Cochran follows:]

FUNDING DEPARTMENT OF ENERGY RESEARCH AND DEVELOPMENT IN A CONSTRAINED BUDGET ENVIRONMENT

HEARING OF THE SUBCOMMITTEE ON ENERGY AND ENVIRONMENT

COMMITTEE ON SCIENCE

U.S. HOUSE OF REPRESENTATIVES

AUGUST 1, 1996

RONALD W. COCHRAN, LABORATORY EXECUTIVE OFFICER

UNIVERSITY OF CALIFORNIA

LAWRENCE LIVERMORE NATIONAL LABORATORY

INTRODUCTION

Mr. Chairman and members of the subcommittee, I am the Executive Officer of the Lawrence Livermore National Laboratory (LLNL) and represent the Laboratory here today. We were founded in 1952 as a nuclear weapons laboratory, and national security continues to be our central mission.

I am here today to discuss with you aspects of Livermore's important research and development (R&D) activities that are pursued in partnership with U.S. industry. I appreciate the committee's interest in stretching federal research dollars as far as possible. In the face of increasingly tight federal budgets the long-term health of nationally important R&D efforts is a critical concern. These investments in science and technology are necessary for the vitality of economic growth. Your questions specifically pertain to ways to reduce Departmentt of Energy (DOE) R&D expenditures through various possible non-federal cost-sharing mechanisms. Partnerships with industry do improve the quality and cost-effectiveness of Livermore programs. However, factors which I will discuss limit the prospect for depending much more heavily on private capital to defray the cost of R&D activities at Livermore and other DOE national laboratories.

I wish to emphasize three specific points:

- First, we have for many years used partnerships with industry to pursue many of our R&D mission objectives. These partnerships make the federal research we conduct more affordable and/or they allow us to achieve R&D objectives that otherwise would not be attainable.
- Second, we employ a variety of means for partnering with industry. These means increased in the last several years through the establishment of Cooperative Research and Development Agreements (CRADAs) and the Technology Transfer Initiative (TTI) in DOE Defense Programs. Through experience gained, the processes we use are becoming more efficient and routine. The selected partnering mechanism in each case depends on our specific needs as well as the state of the technology and its potential benefits and development risks.
- Third, as a national laboratory, we focus on nationally important, long-term (and frequently high-risk) R&D programs for which the federal government has traditionally assumed responsibility. At the same time, many companies are shortening their R&D horizons and limiting their investments. Accordingly, the amount of direct cost-sharing we can expect with the private sector is quite small compared to our overall budget.

PARTNERSHIPS TO ACHIEVE R&D GOALS MORE EFFECTIVELY

Partnering with industry is integral to the way we pursue programmatic activities at LLNL because it makes good business sense. Our joint efforts with industry apply core mission capabilities to problems of mutual interest and enhance those capabilities. Mutual interest means that there are prospective mutual benefits. From our perspective, two benefits are most important:

- We form partnerships with industry in areas where our R&D needs drive the market.
- We form partnerships to achieve program goals cost effectively.

Partnerships where our R&D needs drive the market

The Laboratory's missions do, in fact, drive very special segments of high-technology industry. The supercomputing industry has been highly responsive to our defense needs, high-power laser component and precision optics firms strongly support Livermore's laser program, and high-speed electronics firms have important customers in our many experimental physics programs. In these cases, the partnerships—mostly through procurement—indirectly "defray" R&D costs by sharing some development risks and providing critical financial and technical support that makes vital program objectives attainable.

Advanced Supercomputing. As an example, our national security needs drove the market for supercomputers for three decades. High-performance computing has always been central to scientific programs at Livermore because we have always needed state-of-the-art computers to simulate the highly complex physics of nuclear weapons. Currently, nearly 10% of the Laboratory's annual budget is invested in the development of systems software and applications for major programs at the Laboratory.

Presently, two factors further enhance the importance to Livermore of partnerships in computer software and hardware development. First, we are entering a post-Cold War era with no nuclear testing. We must rely even more on high-performance computing to assure the safety and reliability of the stockpile, and we need over a thousand-fold increase in computer speed and data storage capacity to model physical effects with greater fidelity and resolution. Second, the future of high-performance computing is undergoing a major transition from conventional (single- or vector-processor) supercomputers to massively parallel processing (MPP) with many microprocessors. To realize the potential that MPP offers, there must be close cooperation among hardware developers, software developers, and users.

As part of the DOE Defense Programs' Accelerated Strategic Computing Initiative (ASCI), the DOE national security laboratories are working with the developers of MPP computers in a multi-year cooperative effort to reduce obstacles to creating efficient, high-performance parallel programs. New numerical algorithms and programming techniques are required for efficient use of the capability of the new machines. In addition, we are working cooperatively on necessary improvements to information management systems, data storage systems, computer networks, and computer graphics systems. Through these partnerships the DOE will obtain computing capabilities that we need for stockpile stewardship and management. Industry will obtain sophisticated customers who can help ready their prototype computer systems and associated software for more widespread future commercial applications.

Just last week, the President announced the award of a $93 million contract to International Business Machines (IBM) to install at Livermore a supercomputer that will be 300 times faster than today's most powerful computers. Installation of the first 64 of 512 planned nodes will take place in the next several months so that Livermore scientist can begin developing necessary software. These nodes, each consisting of 8 powerful microprocessors, will be upgraded next year and all of the nodes will be installed by 1998.

Laser technologies and ICF. The Inertial Confinement Fusion (ICF) Program at Livermore likewise has a long history of very important industrial partnerships, many driven mainly through procurement. The development of the Shiva laser in the 1970's and the Nova laser in the 1980's relied to a large extent on such partnerships. To a considerable extent, U.S. manufacturers applied their own resources to achieve the necessary technological advances in optics and electro-optics to meet the exacting requirements for these powerful laser systems. In turn, companies, large and small, acquired new technology and expertise, developed advanced fabrication methods, and lowered production costs, while creating unique products for the world marketplace. The next major step in the national ICF program is the National Ignition Facility (NIF), which is critical for stewardship of the nuclear weapons stockpile. NIF requirements are driving commercial-sector advances in low-cost, large-scale precision optics manufacturing techniques and technologies for electro-optics, high-speed instrumentation, micro-fabrication, and advanced imaging devices.

Partnerships to achieve program goals cost effectively

We derive very real benefit from executing some of our mission-related work in concert with the commercial sector. This strategy enhances the cost-effectiveness of our efforts. When needed capabilities already exist outside the Laboratory, partnership through procurement can save program money. In total, roughly half the Laboratory's budget is devoted to commercial purchases. When development is required, partnerships can defray government expenses through cost-sharing arrangements.

Since the passage of the National Competitiveness Technology Transfer Act of 1989, we have used Cooperative Research and Development Agreements (CRADAs) as a mechanism for jointly pursuing R&D activities while protecting the intellectual property rights of the participants. As of the end of May 1996, we have executed 228 CRADAs (involving 250 companies, including 70 small businesses) with an estimated total dollar value of $668 million. Slightly more than half the total is private money invested by our industrial partners principally in their own R&D facilities (no public funds are transferred to them). We expect Laboratory and industry investment in CRADAs to be about $24 million next year as the targeted TTI moneys to DOE Defense Programs are reduced. TTI funding at Livermore has declined from $55 million in FY1995 to approximately $15 million expected in FY1997.

To realize cost savings and effectively defray federal R&D expenses, CRADAs must be integral to Laboratory programmatic activities and contribute directly to programmatic goals. Current LLNL CRADA activities are closely aligned with our core competencies and programmatic thrusts in national security, energy and environmental sciences, and biosciences. Principal areas of CRADA investment include: materials and manufacturing; computing and communications; semiconductors, microelectronics and photonics; and biotechnology.

Laser technologies. The laser program at LLNL has 26 CRADAs with industrial partners, totaling over $160 million in the areas of microelectronics, photonics, information storage, advanced manufacturing, precision optics, biotechnology and environmental research, all of which support DOE missions executed at LLNL. As an example, the Advanced Microtechnology Program (AMP) at LLNL is working on aspects of extreme ultraviolet (EUV) lithography. We are collaborating with scientists at Sandia and Berkeley national laboratories and eight industrial partners in activities to help regain U.S. dominance in the $60 billion/year semiconductor manufacturing industry. This project is aimed at developing technology for the manufacture of computer chips that will be 10 times faster and with 1000 times more memory. The technologies embedded in the LLNL participation in these CRADA activities are also essential to the successful completion of the NIF and attendant stockpile stewardship experiments. Just last month we achieved breakthroughs in two critical technologies: one enables greater precision in optical devices used in manufacturing and the other reduces the defects in the masks that transfer circuit patterns onto chips. A Semiconductor Industry Association official characterized Livermore's work as being "very significant progress . . . This is a very important discovery."

Stockpile stewardship. Over the last several years, DOE Defense Programs' Technology Transfer Initiative (TTI) funding to LLNL provided the impetus for establishing closer Laboratory-industry ties and the basis for growth of these interactions. Most of our TTI-funded CRADAs have supported either the Accelerated Strategic Computing Initiative (ASCI) or technologies applicable to maintenance of an affordable, safe, and reliable nuclear stockpile. These include partnership activities in advanced engineering design capabilities, precision manufacturing, materials processing, and non-destructive evaluation. Important weapons program efforts have been enhanced through these partnerships. Our multi-year CRADA commitments are being adversely affected by reductions in TTI funding, and we are examining carefully which ongoing activities are most central to our programmatic needs.

PROCESSES FOR FORMING COST-SHARING PARTNERSHIPS

The mechanisms we use to form industrial partnerships include Nondisclosure Agreements, CRADAs, Work-for-Others Agreements, Licensing Agreements, Small-Value CRADAs, the Small Business Innovative Research and Technology Transfer Research programs, Technical Assistance Agreements, the National Machine Tool Partnership Consulting Agreement, User Facility Agreements, and Personnel Exchange Agreements. The use of each of the mechanisms requires negotiations between LLNL and the prospective partner. Two of the processes merit particular attention:

- CRADAs provide means for defraying R&D expenses by sharing costs and risks with a partner. Other means for cost-sharing R&D are also possible, but in all cases a central issue is intellectual property rights.
- Licensing Agreements enable us to move technology invented at the Laboratory into the marketplace while protecting the inventor's intellectual property rights and generating royalties. They are frequently part of CRADAs. More generally, we have a responsibility to see that public benefit is derived from our R&D, often meaning that new products result in the private sector. Through reinvestment of royalties that come to the Laboratory, we can help defray R&D costs, which directly benefits DOE programs.

CRADAs as a means for defraying R&D expenses

In FY1996 Livermore is engaged in 143 CRADAs totaling about $61 million for the LLNL portion of the activities. Of this amount, DOE Defense Programs TTI funds about $51 million and another $5 million comes from "funds-in" CRADAs (our industrial partner covers all or a portion of the Laboratory's expenses). The other $5 million comes from non-TTI programmatic R&D funds that we have chosen to invest in CRADA partnerships. Our projection for FY1997 is $24 million in total at LLNL for CRADAs. The industrial partners' efforts will exceed the LLNL investments.

The process for establishing CRADAs continues to improve. We work with DOE to shorten and make more flexible the process for developing, approving, and executing CRADAs. The changes introduced to the process, at the national and the local levels, are heavily influenced by lessons learned from previous CRADA experiences and feedback from our industrial partners. The goal of the continuing process improvement is to better serve prospective partners, for whom time is money in a competitive marketplace, and our programs for DOE, which expect to derive direct benefits from the cooperative efforts. A CRADA which took 18 months in 1991 now at times can take less than 90 days to execute, from start to finish.

Within the Laboratory, processes have been established to manage our CRADA efforts from project selection through to the final reports and customer surveys. The Laboratory Deputy Director for Science and Technology oversees the activities. He has been supported by an external Industrial Advisory Board and uses an internal Industrial Partnering Working Group (IPWG) as an executive steering group. The IPWG has a role in the selection of CRADAs to pursue and the review of ongoing agreements. Members of the IPWG are also responsible to the Deputy Director and their respective Associate Director for the quality and performance of partnership activities within their areas of the Laboratory. Semi-annual reports are prepared for each set of activities that review planned and actual costing and performance compared to contractual milestones. In addition, annual program reviews are conducted. Final reports are prepared jointly by the partnership team, and we conduct a customer survey to find out how well Livermore met our partner's expectations during the technical execution of the CRADA.

Licensing as a means for moving technologies out of the Laboratory and generating royalties in the process

The Laboratory is a very inventive place. Researchers file about 250 invention disclosures yearly. Inventions raise opportunities for the licensing of potential commercial products and generation of royalties. The quality of our inventions is reflected in the fact that Livermore has received 61 prestigious R&D 100 Awards—six of them this year. Two of the most recent R&D 100 Awards were presented to technologies that Livermore developed as part of CRADA partnerships. CRADAs are enabled by arrangements to share intellectual property rights, such as through licensing agreements.

For each patented (or patent-pending) Laboratory invention, our licensing staff determines whether there are sizable commercial possibilities. If so, they issue a public announcement to contact potential licensees. Interested firms are invited to LLNL for preliminary discussions. These discussions are held under mutual nondisclosure agreements so the company cannot use any information the Laboratory divulges about the technology. Likewise, the Laboratory cannot share any information it learns from a prospective licensee.

Interested firms provide the Laboratory preliminary marketing and business- plan information. The company or companies chosen to receive a license are not necessarily the largest firms competing but the ones LLNL licensing specialists believe will be the most successful at bringing the new product to market quickly and marketing it effectively.

The final step is drafting a licensing agreement. Domestic commercialization of technologies is a dominant consideration and the license and royalty fees we negotiate are based on common industry practices. There is no standard royalty structure; it depends on the product, the market, and other relevant business considerations. To date, we have negotiated rights to more than 100 Livermore technologies. Two examples are illustrative:

Micropower Impulse Radar. The Micropower Impulse Radar (MIR) is the most noteworthy example of commercialization of LLNL-developed technologies. The MIR, featured last year on the cover of *Popular Science* magazine, was invented by LLNL scientists searching for ways to measure the effects of fast laser pulses. The invention uses roughly $10 worth of off-the-shelf components to outperform, in some ways, conventional radar and sensor equipment costing $40,000 and more. It may well transform entire U.S. industries with new generations of "smarter" commercial and industrial products.

Industry has been quick to see the value of this technology. LLNL has received more than 4,000 inquiries from 15 countries. Sixteen licenses have been issued and another fourteen are pending and expected to be issued. Products are beginning to enter the marketplace. Applications range from national security to products for the home and transportation (e.g., collision avoidance systems). MIR will significantly influence products such as burglar alarms, appliances, toys, robots, vending machines, and healthcare equipment. As an example, the technology most recently won its second R&D 100 Award for application as an "electronic dipstick" that can sense the level of fluid or other material stored in tanks, vats, and silos. The dipstick can be used in automobiles to read levels of a variety of fluids: gasoline, oil, transmission fluid, coolant and windshield cleaner.

High speed cell sorters. Livermore is one of three DOE designated Human Genome Centers and completed last year a high resolution mapping of human chromosome 19. This mapping is helping researchers worldwide to characterize the diseases associated with genes on chromosome 19. Our human genome efforts grew out of our research interests and key breakthroughs made by Livermore researchers that led to methods for high-speed sorting of individual chromosomes (flow cytometry). Having developed the world's fastest device to analyze and separate cells and chromosomes, we licensed rights to manufacture the device on a time-limited exclusive basis.

The licensee converted the LLNL design for commercial production. Research applications include development of pharmaceuticals and studies of infectious diseases including AIDS. Potential clinical markets include detection of rare malignant cells in blood and the study of fetal cells in a mother's peripheral blood, providing a noninvasive method of prenatal diagnosis. As one prominent pioneer in genetic research commented, "You never know what interesting and major breakthroughs may result when you provide researchers with such a state-of-the-art tool. This is an important tool in an area that will be extremely significant in the next decade."

LIMITATIONS TO DEFRAYING R&D EXPENDITURES

As I have indicated, we pursue industrial partnering to support and enhance our programmatic efforts to meet important national needs in a cost effective manner. At the same time, American industries can tap into our cutting-edge technologies, capabilities, and facilities to bolster their competitiveness in the global marketplace. It is a fruitful relationship, and I expect working collaborations to continue to flourish.

But we must be mindful of the level of activity at which partnering flourishes and the barriers which exist that limit the potential for dramatic increase. CRADAs, in effect, defray $10's of millions in R&D expenditures at the Laboratory (either funds coming to Livermore to pursue R&D or investments made by partners at their facilities that directly contribute to our research goals). The royalties we received last year from licenses were on the order of $1 million. In comparison, the annual budget for the Laboratory is roughly $1 billion. There is a very large difference between public and private investments in Livermore.

A central issue is the role of a national laboratory. As a DOE multiprogram laboratory, Livermore conducts multidisciplinary R&D on large, complex problems where national interests are at stake. Frequently the research is high-risk and has long time horizons. These efforts require a sustained commitment from our customer, the American public. For Livermore, our defining responsibility is national security. It requires unique capabilities at the Laboratory that we also focus on specific important national needs in energy, environmental sciences, and biotechnology.

The overall impact of our R&D must be benefit to the public good. Although tangible, the benefits of long-term R&D are often diffuse and usually difficult to quantify. In the energy and environmental areas for example, the benefit to the public frequently derives from downstream products in (or capabilities provided by) the private sector. The connecting bridge between long-term R&D and products is usually not obvious, and the largest benefits are often not even anticipated. Even when the bridge is apparent, it can be lengthy and difficult to cross. The task is made more difficult by current trends: a greater need to cut costs and an even shorter-term R&D focus (the next product out the door) in industry. Ironically, given current pressure for strong corporate performance, the prospect for significantly greater private investment in long-term R&D at the national laboratories is weak now, at a time when it would be most valuable because of federal budget pressures to reduce public investment in R&D.

Three examples highlight issues about the bridge between R&D investments at Livermore and transition to products out the door:

Atomic Vapor Laser Isotope Separation (AVLIS). AVLIS is a technology that promises to provide a low-cost production capability to enrich uranium for use as reactor fuel. Its development could help assure a long-term competitive position for the United States in the global marketplace. The DOE recognized the potential importance of AVLIS and started to pursue work on the technology in the early 1970's. After two decades of successful R&D and a DOE investment of about $1.4 billion, responsibility for AVLIS was transferred in 1992 to the United States Enrichment Corporation (USEC), a government corporation. USEC has decided to take the first steps to construct and operate an AVLIS plant for uranium enrichment. They are continuing to fund AVLIS R&D at Livermore ($102 million in FY1996) and are working very closely with Laboratory scientists to ensure success in this effort. The AVLIS project has the potential to become the largest technology transfer effort to the commercial sector in the Laboratory's history. It is an excellent example of federal government foresight and commitment, a highly successful long-term R&D effort, and careful attention paid to details concerning the transition from research to commercialization.

Dynamic Stripping for Environmental Remediation. Remediation is underway to cleanup underground carcinogenic solvents at the Livermore site. Using standard pump-and-treat technology, the effort would take 20 to 50 years and cost between $300 million and $500 million. Working with University of California Berkeley colleagues, we conceived of a cleanup process known dynamic stripping that would allow the work to be completed much faster at much lower cost to the taxpayer. But we had to test it first. As an R&D experiment, we used dynamic stripping on a spill of 10,000 gallons of gasoline that leaked from an underground tank at the former service station at LLNL. The gasoline was recovered at a cost one tenth that of conventional excavation techniques and in nine months instead of the decades that pump and treat would have required. With a successful demonstration under our belt, we are now working with DOE on a proposal to accelerate the cleanup of LLNL using this and other experimentally-demonstrated but not-yet-commercial cleanup techniques. We are also better able to line up industrial partners to commercialize the technologies so that they can be used to reduce cleanup costs nationwide.

The PEREGRINE Project and improved cancer treatment. Each year over 1.3 million people in the U.S. are stricken with cancer and more than 500,000 cancer patients die. Half of the deaths are related to the physician's inability to eliminate the primary tumor. In many other cases when radiation treatment succeeds in eliminating the cancer, excessive doses damage healthy tissue and cause complications. The healthcare industry currently has only simplified models and calculational tools to predict the dose to tissue. At Livermore, we are drawing on the special skills in our nuclear weapons program to develop new computational models that will allow physicians to estimate far more precisely on a case-by-case basis the dose required in radiation treatment of a cancer. This is the PEREGRINE Project.

We believe PEREGRINE is an important investment for the public good. It is initially being pursued at Livermore as a Laboratory-Directed Research and Development project. Clinical collaboration is being provided by a number of medical research institutions and universities. As PEREGRINE matures, it must transition into an effort with a much larger base of public and/or private funding support and involvement of an even broader range of stakeholders in the healthcare industry.

These examples illustrate that the route from concept to commercialization can be complicated and that there is a role for public investment before private investment kicks in. Some national needs require considerable national investment over a long period of time. Private funding figures in later, and details depend on the particulars of the case. AVLIS is now beginning to be commercialized and nuclear fusion for energy security in the middle of the next century is another example where the transition is still well into the future. Other important needs can be addressed on a shorter time scale and require less investment. Yet the transition from public investment to private investment can be complex for a variety of reasons.

CONCLUDING REMARKS

Private investment in Laboratory R&D through industrial partnering is working. It makes sense for the Laboratory and for U.S. businesses. American industries can tap into our cutting-edge technologies, capabilities, and facilities to bolster their competitiveness in the global marketplace. At the same time, we benefit from forming partnerships selectively with industries to support, enhance, and make more affordable our programmatic efforts to meet important national needs. It helps defray R&D costs, but only to an extent $10's of millions per year in direct investment into Livermore, which has a $1 billion per year budget. The prospect for private investment to defray a much greater fraction of the R&D expenditures seems to be quite limited with our focus emphasizing long-term, high-risk R&D in the national interest. Even so, we must continue to work the issue of bridging the gap to ensure that our R&D efforts ultimately lead to products that improve the quality of life for all Americans.

Mr. ROHRABACHER. Dr. Gay?

STATEMENT OF DR. CHARLES GAY, DIRECTOR, NATIONAL RENEWABLE ENERGY LABORATORY

Dr. GAY. Thank you, Mr. Chairman and Mr. Baker, for the opportunity to be here today.

I have submitted some written testimony that I would like to have entered into the record, if I could.

Mr. ROHRABACHER. Without objection, and we appreciate you summarizing your testimony.

Dr. GAY. I will.

I have been the Director at the National Renewable Energy Lab for about one-and-a-half years and, prior to that, the president and founder of several manufacturing companies for a 20-year period, so I have some experience in the industrial and in the government side looking at the role and interaction—complementary, corresponding roles—that industry and government can play together. So I have some strong opinions as to ways that we might optimize the goals here.

Much of the discussion today I believe has focused relatively narrowly on applying some of the principles that work in industry to options that might be available to the Federal Government.

As we have spoken about, through the earlier testimony, some of the particulars we have tended to pick specific examples.

What we have been looking at is how to apply sort of a general category that would capture a couple of those specific examples.

What I would like to do this afternoon is just briefly talk about how to focus on what the market may be for the opportunities we have to be able to raise financing in order to support tasks from the capabilities within the laboratory.

Let me start out by saying this country has a history of funding R&D that probably goes back at least to Lewis & Clark in looking for a trail to the Pacific Coast.

That funding benefitted not just Lewis & Clark in terms of their recognition in our history books, but an awful lot that followed in the development of our history and the identification of the map of possibilities that could benefit future generations.

That is a tradition in the role of government here in the U.S. that has made our country very strong.

There is no one specific beneficiary in that example that could be charged to repay the cost of the Lewis & Clark trip. In today's complex maze of global competition and drive to promote near-term return on shareholder investment, it is very important to look at how we may balance the roles of government and industry.

Competition is a lot more complex, and a lot of the technological discoveries today boil down to who goes first in order to prove that something can occur.

If you know that there is a trail to Oregon, the first key piece of data is that there is a trail to Oregon that exists and that you can build a business going along that particular trail, and others are able to follow you quickly and save the cost of the R&D that was necessary in order to get there in the first place and prove that you could get there.

DOE invests its tax dollars, or the tax dollars from the American Taxpayer, in promoting a general interest to the Nation by focusing on some strategic missions that result in the improvement of the diversity of our energy supply options, keeping our environment, clean, and creating jobs in a diverse portfolio of energy technologies that we are going to need for our future in ensuring that our industries remain competitive.

With regard to the principal theme of this hearing, and with comparing up-front cost sharing, I would say that is a much better instrument than back-end recoupment as a way to accomplish the complementary missions of both industry and the government, and in this case the Department of Energy.

The main reason, I would assert, for cost-share and recoupment is not to offset appropriations' funds, but to better ensure that the full benefits of the R&D that we carry out in this country can be derived in the formation of jobs and economic development.

Industrial opportunities are important, and we look at those in the nature of the relationships that we have at the National Renewable Energy Lab. Over half of the funding that comes to the laboratory goes back out to industry and to universities in the form of cooperative arrangements in order to assure that the technology moves rapidly from the laboratory into commercial use.

The main reason I feel that the role of cost-sharing is important is that it is a way to better ensure that the full benefits of the government investment are achieved; and that this is accomplished by knowing that the businesses with whom we are cooperating are serious, because they are putting in their own money in order to match us and what it is that we as the government do, and that requires risk-sharing on the part of both the government and on the part of the industry.

There is an incentive there to speed that process from discovery to commercialization.

It also provides a mutual leverage to the parties that are involved by maximizing the net gain that the industrial side is seeking and that the government is seeking in a diverse portfolio for its energy supply.

And, by cost sharing we establish a formal framework for the nature of the relationship that we would like to cement together, CRADAs being—Cooperative R&D Agreements being one primary example that we have talked about here today.

Cost-sharing leads to jobs and to profits. When we create jobs, individuals pay taxes back to the Treasury, which is the source of the funding we have been working with.

When we succeed in creating profitable corporations, they also are paying taxes back into the Treasury.

It is my experience in running businesses that some of the direct manufacturing jobs that we created in new technologies—primarily renewable energy technologies—not only provided the direct benefit from those jobs, but the additional jobs in the upstream supplier side, and in the downstream distribution marketing side.

My view is that the government needs to have a stable and consistent policy across all of the government-sponsored R&D areas, not just in energy; and that we need to be especially favorable in our consideration of small entities that may not be in a financial position to both cost-share up front and to repay through recoupment mechanisms on the back end in order to maintain this vigorous job growth and job creation responsibility that we have as part of our economic development goals.

I would like to close by commenting that the DOE does have a group working on alternative financing scenarios for R&D under way at the direction of Deputy Secretary Charles Curtis, with a final report that is expected to be issued at the end of October of this year, motivated in part by the increasing awareness of the serious out-year budget implications of the need to achieve a balanced budget for our Federal Government and by the recommendations of the Galvin Task Force which took a strategic look at the role of R&D and the opportunities for alternative financing of the DOE and the laboratories.

There are many different kinds of mechanisms that can work here. We need to focus on how to market the technology we have in order to select the most appropriate mechanism.

Thank you for the opportunity to comment today.

[The prepared statement of Dr. Gay follows:]

TESTIMONY OF DR. CHARLES F. GAY, DIRECTOR, NATIONAL RENEWABLE ENERGY LABORATORY

BEFORE THE U.S. HOUSE OF REPRESENTATIVES

COMMITTEE ON SCIENCE

SUBCOMMITTEE ON ENERGY AND ENVIRONMENT

HEARING ON FUNDING DEPARTMENT OF ENERGY (DOE) RESEARCH AND DEVELOPMENT (R&D) IN A CONSTRAINED BUDGET ENVIRONMENT

AUGUST 1, 1996

Thank you, Mr. Chairman, for allowing me to contribute to this hearing on options for funding the research and development (R&D) programs of the Department of Energy (DOE) during a time of constrained federal budgets. One issue before the Subcommittee of particular interest to me is the relationship between various cost-sharing and recoupment methods such as cost-shared subcontracts, repayment provisions, cooperative research and development agreements, and patent licensing, and the amount of federal funding required to effectively carry out DOE's R&D programs.

My comments focus on the general question of how cost-sharing and recoupment methods might impact DOE's R&D programs, in particular the renewable energy R&D programs of the National Renewable Energy Laboratory (NREL). I defer to DOE personnel the task of addressing the Subcommittee's questions related to DOE's department-wide use of specific cost-sharing and recoupment methods.

My general view is that while cost-sharing and recoupment can have a positive impact on R&D programs in certain circumstances, much of the present discussion is too narrowly focused on the use of such mechanisms to offset federal investment in R&D.

COST-SHARING AND RECOUPMENT IN R&D

Cost-sharing and recoupment methods, broadly defined, are used widely by business and government today. Private-sector businesses use "front-end" cost-sharing to better manage risk and use "back-end" recoupment such as differential profits from R&D discoveries to pay for R&D expenses. Public sector entities, such as DOE, generally use cost sharing to better marshall the resources needed to accomplish their missions and use recoupment techniques to recover all or part of the public's investment in R&D that creates profits for private sector entities. My personal view is that recoupment of public sector R&D funding is generally not as advantageous to DOE aims as is cost sharing.

Private-sector businesses use cost sharing and recoupment to improve the overall risk/benefit profile of R&D. Cost sharing has numerous potential benefits, including:

- Reducing known up-front costs in exchange for sharing subsequent benefits
- Forming strategic alliances to assemble the resources necessary for complex undertakings, for example, gaining complementary expertise or critical mass
- Serving as a path to other benefits such as broader alliances down the road
- Securing strategic "options," for example, intellectual property rights to innovations.

For the private sector, "recoupment" can be broadly defined as the profit motive underlying investment in R&D. Simply stated, businesses invest in R&D with the aim of generating future profits. Some operations are "R&D companies" whose sole focus is on developing technology to be licensed or sold to others. More typically R&D is one of many investments that businesses make to insure growth and profitability.

Cost sharing and recoupment have entirely different purposes and impacts on public-sector investments, such as those undertaken by the Department of Energy. The main purpose of DOE's energy R&D program is to facilitate meeting America's energy and security needs. Efficient investment of federal funds in R&D involves directing resources to proper targets and structuring the terms of the funding so as to best leverage the federal investment. In the context of DOE's R&D programs, cost-sharing and recoupment are just two of many methods used to best target and leverage investments.

The main reason, as I view it, for DOE to use cost-sharing and recoupment is NOT to offset federal, i.e., Congressionally appropriated funds, but rather to better insure that the nation reaps the full benefit of DOE's expenditures on R&D. In the case of cost sharing, this:

- Assures that businesses are serious about the subcontracted research and development and capable of advancing the results of that R&D to market. Requiring that companies risk their own monies in R&D projects creates a natural incentive for them to rapidly move the R&D results to market
- Provides mutual leverage to the parties involved—because government funds are matched by private funds, and vice versa—to maximize net productive investment in the targeted areas
- Provides a formal framework for structuring collaboration between public and private entities as, for example, with Cooperative Research and Development Agreements (CRADA's).

In the case of recoupment, DOE uses measures such as repayment and royalty-bearing licenses to improve leveraging of federal expenditures on R&D by garnering for the taxpayers a portion of the profit from new technology advances. If federally funded research yields significant profits to industry, then recoupment is a simple, arms-length method for government to share in the benefits in return for having shared in the risks.

However, recoupment can be counterproductive if repayment or royalty-bearing licensing terms become onerous, thereby undermining the commercial competitiveness of the technology. Also, it has been argued that recoupment of R&D investments is merely an inefficient form of taxation, burdening businesses with additional payments to the federal government, over and above tax payments. Recoupment can also distort decision making if future federal R&D funding is tied too closely to generating revenues rather than to achieving the agency's mission.

Based on my experience, I recommend that cost-sharing and recoupment not be viewed as methods for reducing R&D funding requirements. In fact, it is my opinion that they are not very efficient methods of generating funds. Focusing on R&D funding reductions may well conflict with our national priorities, especially in the area of renewable energy R&D and the expedited transfer of renewable energy technology to industry and the private sector. The nation needs a portfolio of sustainable energy sources just as any considered financial portfolio is a balance of diverse investments. The American public has repeatedly indicated strong support for R&D for renewable energy technologies. I believe that if Congress further reduces funding for renewable energy R&D, there will be severe adverse impact on the U.S. energy future and our economic development.

Cost sharing and recoupment are more properly viewed as tools that DOE can use to increase the effectiveness of the nation's investment in R&D. How these tools are used and for what purpose is quite different for the public sector than for the private sector.

PUBLIC-SECTOR VS. PRIVATE-SECTOR INVESTMENT

I worked in the energy business for 20 years in various roles ranging from research scientist to CEO. I have worked in government as NREL's Director for about 1.5 years. From direct experience I can tell you that there's a world of difference in the "how" and "why" of public-sector versus private-sector endeavors.

At NREL I have worked to instill a more businesslike mind set for operating the laboratory. We have made significant improvements in operational efficiency and have strengthened science productivity while sharply reducing administrative overhead. But that doesn't mean that a national laboratory is just like a business. The basic aims of the private and public sectors are different.

Private-sector investment generally aims to yield individual gain. Within the broad confines of ethical standards of commerce, businesses generally invest to maximize their identifiable, quantifiable, and individual return.

Public-sector investment generally seeks to yield more general, or national benefits. It makes a businessperson uncomfortable to base R&D expenditures on distributed benefits, but that's what government by its very nature does. For example, government builds interstate highways to facilitate commerce and maintains a well-armed defense force to insure our security.

It makes a businessperson equally uncomfortable to base R&D expenditures on benefits to accrue to future generations, but again, that's what government does. Thus government builds flood-control systems and undertakes massive rural electrification projects.

While cost sharing and repayment provide business with a means for initially limiting and eventually recapturing corporate investments in R&D, full monetary repayment per se doesn't make much sense for a government R&D program. Government investments are not made on the basis of monetary gain. Rather, government investment is aimed at collective gains, which include such difficult-to-quantify benefits as national security and improvements in the quality of life. For example, DOE's energy R&D programs are aimed at generating workable energy supply options for the nation, but the private-sector R&D that I managed for 20 years was aimed solely at generating one option in the customer's mind—namely to buy our company's products and services.

Though the return on DOE's R&D is a mixture of difficult-to-quantify collective gains, it IS possible to speak of maximizing the taxpayer's return on that R&D investment. In my view, an important element of DOE's mission—and an explicitly-stated part of NREL's mission—is to facilitate the commercialization of scientific advances and technology improvements that result from DOE's R&D investments and NREL's program execution. Simply stated, our nation most directly benefits when the technology developed by DOE R&D is promptly and aggressively commercialized by the private sector.

Cost-sharing arrangements can accelerate commercialization by guiding DOE R&D investments to those private sector research partners most likely to commercialize the results of the subcontracted or collaborative R&D. For this reason, I support these arrangements. But it is imperative that the terms are reasonable and do not put U.S. industry at a competitive disadvantage vis-a-vis its international competitors.

However, recoupment arrangements such as license fees or repayments—unless very judiciously and selectively used—can inhibit and even negate the achievement of the underlying purpose of DOE R&D investments by eroding the commercial viability or competitiveness of technologies developed with DOE funding. For this reason, I generally oppose these arrangements, though I see considerable merit in exploring methods by which taxpayers can share in the upside potential of—and ultimate profit from—federal R&D investments.

IN PERSPECTIVE

It must be emphasized that the PRIMARY elements for success in maximizing the nation's investment in energy R&D are NOT cost-sharing and recoupment arrangements for leveraging DOE's R&D investments; rather they are sustainability, diversity, and continuity.

Government investment in energy R&D should be directed at developing the sustainable energy resources that the Nation needs for long-term security, job creation, and economic prosperity, and environmental quality, using the market as a directional pointer.

Government investment in energy R&D should encompass a broad and diverse portfolio of energy resources, including near-term, intermediate-term, and long-term targets. Investment should be aimed at generating workable technology options that then compete unfettered in the private-sector marketplace, both nationally and internationally.

Government investment in energy R&D requires reasonable continuity and consistency to maximize the return on that investment. It is possible to buy a fast car or a flashy suit of clothes in a quick burst of spending, but lasting accomplishments of real value—a well-built house, a college education, rearing a child with integrity and solid values—require steady continuity of commitment and investment. Renewable energy is on track to become one of this nation's lasting accomplishments of real value. For example, manufacturing costs of photovoltaic products have fallen 100-fold over the past 20 years, and renewable energy technologies are proving to be cost-effective energy sources for numerous applications in domestic and international markets.

Now is not the time to falter in the continuity of our prudent investment in renewable energy R&D.

Thank you for your time.

Mr. ROHRABACHER. Thank you, Dr. Gay.

I think that in relationship to what you just said, that is what this hearing is all about.

We have a situation in the post-Cold War World where your relationship with the government is going to be lot different than it was during the Cold War. That is the bottom line.

We need to start defining what that is going to be by making sure that things are systematized and that fundamental principles are laid down, but they are going to be different than they were during the Cold War.

One thing that I would like to note before I—well, maybe I will just ask the panel this, as well, to comment on this—I mentioned passing a strong patent system, and most of you know that I have been involved in a big fight here on Capital Hill in defining what patent rights really are.

When we start talking about payback for the development of these technologies, if we do not have a patent system that strongly protects the inventor, or the owners of that technology, there is not a payback system that is going to work, is there?

This is dependent on a strong patent system, is it not?

Go right ahead.

Dr. GAY. I would like to just offer a comment to just sort of put this in some perspective.

Certainly it is important to have a strong intellectual property protection system of which patents are one piece. As Ron has indicated and other presenters here today, the percentage of omnibus positions that could be established in order to see significant cash flows resulting from licensing fees is a fairly small number.

From the studies I have seen that have been conducted at Stanford in licensing of their patents, the number is around 1 to 2 percent of the patents that have been established provide for the majority of the cash flow that is seen from having those patents.

In industry, patents generally are used like trading stamps. You establish a particular position in your industry. There may be competitors who have created alternative technical approaches to achieving the same function and have a patent position in their portfolio, and businesses exchange mutual licensing rights with each other.

Mr. ROHRABACHER. Let's take a look at what Dr. Cochran talked about when he spoke about the micro power impulse radar, which is something, again, after Bill Baker beat us up to make sure we had to come up there and visit the plant, that we got a first-hand look at what that was all about. This shows you why it is valuable for us to come up and to get a first-hand view of what is going on.

This radar chip is basically what we are talking about here? Is that what we are talking about?

Dr. COCHRAN. That is correct; yes, sir.

Mr. ROHRABACHER. And did I see, or did I not see, the radar chip held up to someone's throat and used as a microphone?

Dr. COCHRAN. Yes, sir. You saw that. That is one possible application.

Mr. ROHRABACHER. I mean, this is an incredible thing. This is not going to be worth "$8 million," like you were mentioning in your testimony, that you have an $8 million—this potentially could be worth hundreds of millions of dollars, if not more than that.

Dr. COCHRAN. We hope so. Yes, sir. The potential is there.

Mr. ROHRABACHER. The potential is there.

Now I don't know, maybe the type of research that is going on will not always result, or lend itself over a five-year or a six-year period to something that could learn this kind of result, but it seems to me that that potential is there for your laboratories if you are doing the right thing.

We do not know what possibly can come out of this. This radar device could—we have all heard these people who have had cancer in their throat and they have to speak through a device, and it sounds pretty gruesome, but this device could well be used for those people—although I am not sure—

Dr. COCHRAN. Yes, sir. In fact, that is one of the areas of interest to in fact try that.

It can also be used in place of a stethoscope to monitor your heartbeat and give a great deal more information than is currently possible.

Again, it is a very special case, but as I said we have got 4000 inquiries on this one device, which is very unusual. But the potential for payback looks very, very good.

We have gotten about $1.4 million already, and I think we have just scratched the surface on that. And royalties will then continue to follow beyond that.

Mr. ROHRABACHER. And where will the money go for that?

Dr. COCHRAN. The money comes back to the laboratory for research and development basically. Some of it goes to the inventors, because as Congressman Baker said you have got to incentivize people to want to do the extra work.

This particular one is sort of interesting. It was developed as part of our laser program as basically a high-speed oscilloscope. The inventor had done his job when he made that for the program.

But because we incentivize them to get creative and really press, as you suggested we do, they went further and started saying, gee, you know, we can buy the parts from Radio Shack, more or less, build it cheaply and make it something that is really a commercially viable activity.

We have got to get a lot of partners to do it, but we are proceeding on that path.

Mr. ROHRABACHER. Just to show you to the magnitude of this, this device could also be used as a mine detector.

Dr. COCHRAN. Yes, sir.

Mr. ROHRABACHER. One of the issues I am very concerned with in the post-Cold War world is trying to cleanse this world of land mines that destroy little children's legs all over the world.

You know, somebody plants a land mine and five years later some little child is walking along and its legs are blown off. This is not a rare occasion. We are talking about something that happens every single day.

You get a cheap mine detector out in Cambodia, or Afghanistan, we are talking about a wonderful contribution to the well-being of our society.

These things—in other words, there are things that can happen in the post-Cold War world, and I would hope that in a global market that your profit potential in a global market would make it possible for you not to earn $8 million, but earning tens of millions, if not hundreds of millions of dollars from this type of creative endeavor.

Feel free to comment.

Dr. HARTLEY. Let's see. I think my number was more like $60 million.

Mr. ROHRABACHER. All right.

Dr. HARTLEY. That is our target for what we think it would level out to. It does take a few inventions that are very special. As Dr. Gay said, only one out of several hundred ever amounts to a significant return.

The transistor would be a wonderful thing to reinvent, or the laser. Those things bring a lot of money. This marvelous radar device that Livermore has, the commercial sales of that, you have to be careful with the economics in these projections because the industry that manufactures them may have 20 pieces that are intellectual property, each one of which he is paying a 5 percent royalty on.

So he has to be able to make some money on that, as well. So that actually tracing back how much they will make, it is not the entire sale. It is their piece of it, but it is still very significant.

I would hope we would do hundreds of millions of dollars, too, but realistically to think that we can support an entire lab structure on that, I do not know any evidence of that happening in this country.

Mr. ROHRABACHER. But, you know, when somebody uses the word "realistically," it is always based on what is realistic in today, in "reality." That is what "realistic" means, reality.

Dr. HARTLEY. Yes, sir.

Mr. ROHRABACHER. And what is really important is for us to change reality. That is what science is all about.

Mr. Baker?

Mr. BAKER of California. That leads me into my story.

Ronald Reagan ended one speech with "We can dream big dreams because indeed we are Americans." I think that is what this is all about.

How do we not stifle research with high fees and front-ending, but how do we encourage people to work cooperatively with our laboratories and their wonderful techniques in order to get more out?

So I am very much in favor of that.

Let me ask Mr. Gay, because he argued the other way. He wants more cost sharing.

What percentage of your budget would be returned from your cost sharing agreements today to the renewal lab?

Dr. GAY. What I could speak to is my own experience from the industrial side, having been involved in some cost-sharing in industry, since I have the financial data from that experience.

It relates to a company called Arco-Solar where during about the first approximately 10 years of our company's operation, we created jobs for about 500 people, manufacturing jobs in Southern California.

Corresponding to that was an additional approximately 250 to 300 jobs from the supplier industry that made the components we used to make our solar modules.

Downstream from that was a distributor and dealer network which, just in the United States, although roughly 75 percent of our product was exported, just in the United States there was roughly 70, close to 100 employees in the distributor network and, correspondingly, another 300 employees—

Mr. BAKER of California. I think I get the picture, Dr. Gay. So it is creating jobs. Who is putting the money in?

Dr. GAY. Of that, we received about $4 million in R&D money from the Department of Energy. There were roughly 800 jobs, then, that were created over this 10-year period I am talking about.

So you could make some estimates of what the average salaries were. You may say to first order——

Mr. BAKER of California. But my question was. How much of your budget at the Renewable Lab is paid for by cost-sharing agreements?

The answer is. Tiny few. And they would tend to discourage people from coming to you unless they had a really good fix on a product already.

What I want to do is to have some of that, yes. If you are an end user and you just want to use Livermore's lasers to do a certain thing and that is all you want to do, fine. Pay the cost-sharing.

But if you want to invent a medical machine or device that may save lives and do wonderful things and you are not sure you can ever invent it, all I want to know is, yes, if the government determines that is a good project, and the company determines that is a good project, if you succeed then I want a share in that success.

If you fail, then we have not helped society in that. So I do not like the front-end approach because I think it would discourage research.

And I do not think at the Renewable Lab you really have a lot of cost-sharing.

Dr. GAY. In our CRADA agreements, we have 72 percent of our CRADAs are the industry cost-share. Of the small businesses that have CRADAs with us, 67 percent are industry cost-share.

In the contracted R&D agreements, we have 22 percent of the funding that is industry cost-share.

Mr. BAKER of California. What is the dollar amount? I mean, they are cost-sharing all right, but on what basis?

Dr. GAY. If you look at roughly $90 million of contracts with industry, an additional 20 percent, close to $15 million would be the industry cost-share that makes up the total of a little more than $100 million of contracts with industry.

Mr. BAKER of California. So 20 percent would be a rough figure.

Dr. GAY. Yes.

Mr. BAKER of California. Okay. Let me give you an example. There is a new process—probably not "new," but new to me—known as Aerogel. That is a carbon paper that hopefully will replace the reverse osmosis that is so energy intensive.

It will allow us to take solids like salts out of waste water. If we went out to a water treatment plant—let's say East Bay Mud or San Ramone Dublin Services District and say, hey, we want you to pay 50 percent of this. We think we can take all the solids out much more cheaply, they would laugh at us. Their taxpayers are not paying fees—or their sewer users are not paying fees for them to go out and chase research.

But, if we said we think we have a good process and we are going to build a sample plant for you, if we are successful you are going to get so many millicents per gallon, people would say, yes, I would like to try that. We will put up some money and we will do some sharing with you, but only if it is successful will we have to pay, I think we would have a lot of people coming to the table.

That is the difference.

And in the renewable area, I think it is even more important where the likelihood of success is probably less than even in the manufacturing area.

Let me run to a couple of others because my time is up.

Mr. Hartley, you mentioned flexibility. My problem with that in not having some standards is that we now have a waiver process which both industry and the government determined to use almost without fail.

So even when we have success we waive it.

How do we get around that and still have a flexible policy, as you mentioned?

Dr. HARTLEY. I am not sure which part of the process you are concerned about flexibility.

The biggest issue we deal with in waivers deals with the DOE-added value tax of about 28 percent that funds in from industry. That is frequently waived, most frequently waived, because it seemed to be of value to the labs and for DOE for us to achieve benefit.

Is that the aspect you are referring to?

Mr. BAKER of California. Well, and in the coal process we waived it if it was exported; and we waived this; and we waived that. The industry does not want to pay, and the bureaucracy does not want to put up with the paperwork and the harassment, so everybody just agrees not to do it.

Dr. HARTLEY. Right.

Mr. BAKER of California. So we have to set some standards so there is an incentive for us to collect the fees. I would hope you would help us develop that.

Ron, we are talking about the various high-cost areas like the NIF facility, let's say we build this ignition facility that has high-speed laser.

Would that have any commercial applicability at all?

Dr. COCHRAN. It turns out that it does, in many nondirect ways.

Many of the inventions that we talk about are coming out of that program. To the extent that we can license those inventions, you do get paybacks for that.

Beyond that, we are actually helping create an laser optics' industry which is going to create jobs in the area. We are going to have a company actually build a plant. That company will provide our glass, but also will be available in the area to provide glass to many other applications.

We have done that in the past. It works very, very well. So you do get payback from—

Mr. BAKER of California. When they sell that class to other people, will we get royalties?

Dr. COCHRAN. From the inventions they use, which may or may not be in that particular glass, we will get royalties. But from the glass that they invent and sell, of course we would not.

Mr. BAKER of California. Could you help us then to design a system that would provide that incentive?

Dr. COCHRAN. Sure.

Mr. BAKER of California. And Mr. Hartley, also?

Dr. HARTLEY. We would be pleased to.

Mr. BAKER of California. Give the government flexibility, because we do not think we are going to pay for all research out of royalties or fees.

On the other hand, we want to put the incentives all on our side of the table so that your interest is to go out and find businesses that may need your products, and the business's interest is to come to you for your laser technology.

Dr. COCHRAN. Again, I think the key thing is to design this on the front end so that you can work out a project and so everyone knows that this is part of the deal that there is going to be cost recoupment, and you can work out some very successful arrangements.

Mr. BAKER of California. Good. Thank you.

Mr. ROHRABACHER. Thank you very much, Mr. Baker.

I would like to thank this panel of witnesses. As you can tell, we are serious about trying to do something here, and we would appreciate your continued guidance in this area so that we can work with you and again come up with something that works, and something that benefits you and benefits industry and the American people at the same time.

And by the way, I am informed by my staff that this is not something that we are just going to sit on. We are actually going to try to come up with some kind of legislation in the next couple of months before the end of the session.

So we will be in touch.

Thank you, Mr. Baker, and this hearing is adjourned.

Dr. HARTLEY. Thank you.

Dr. COCHRAN. Thank you.

Dr. GAY. Thank you.

[Whereupon, at 12:40 p.m., Thursday, August 1, 1996, the hearing was adjourned.]

[The following material was received for the record:]

Additional testimony

TESTIMONY from Richard L. Wilkey, President of Fisher-Barton Inc, Watertown WI before the
SUBCOMMITTEE ON ENERGY AND ENVIRONMENT of the
COMMITTEE ON SCIENCE

Thursday, August 1, 1996
Rm. 2318 Rayburn House Office Building

You are acquainted with the report prepared by the University of New Mexico concerning the "Technology Transfer Impact Profiles" wherein the impact of tech transfer and our company was discussed. I could not offer any further insight to that report. I wish to focus on why this program is so important to small companies such as ours, how it worked, why it worked so well, what has resulted from that grant and some observations about tech transfer.

I wish to begin with the why of the story. Our company is a rather traditional company. One that we in the midwest would call a metal bender. We make lawn mower blades. A simple product that you would not think required any degree of high technology. However like many things, mower blades are complex. It is an item that has the potential of causing a lot of damage. Typically a mower blade weighs about 2.5 pounds and runs at about 200 MPH. There is a lot of kinetic energy associated with a blade. This requires a great deal of care. When I started my company in 1978, we did not pay much attention to the engineering parameters. We used a process that had been used by others for a number of years and that seemed to work. About the time we really got out company rolling, products liability reared its head. The mower manufacturers had to find a way of making their machines safer. From our stand point, this meant that machines would be made with blades that could stop much faster that ever before. Shorter stopping times meant that we would have to reduce the mass in the blade in order to get braking systems that would hold up over long periods of time.

We had to develop engineering standards for our products. We needed to know specifically what the blade could do from a fatigue and strength point of view. At that time we were a very small company with about 25 employees. We simply did not have the resources to do the research needed. We turned to the University of Wisconsin for help. There we found a graduate student who would use our problem for his thesis. In a matter of a couple of years we collected a great deal of information which allowed us to develop blades that would begin to achieve the characteristics necessary to solve the manufacturing problems we were facing. That was the beginning of our tech transfer activities.

We worked on lighter blades successfully, however the consumer was not very excited about what they perceived as a reduction in quality. The typical consumer thinks of a heavier product as being a better product. That is true from a wear stand point as products wear away a little at a time and the more material available the longer it will last. The solution of one problem, lead to another. We now had to find a way to make the blade last longer. We went back to the University and enlisted more graduate students to help us. That lead us to Plasma spraying. We found a graduate student who found this interesting and challenging. The process showed promise however the University did not have the facilities we needed. We learned the theory but lacked process information. We needed to take the next step.

To solve our problem we turned to the government labs. In 1987, we made application to DOE for a Tech Transfer grant to work with Sandia thermal spray scientists. We sent an engineer to Sandia to learn the process. We had some problems that we could not solve. By then we saw the plasma spraying process as a way to solve a whole series of problems in industry. We took those and our blade problems along to Sandia.

While we wanted solutions to our immediate problems, we were more interested in developing the expertise that we could use to solve long term manufacturing solutions. In conjunction with the scientists at Sandia, we decided that the best way to gain the kind of process information would be to work hand in hand with the Sandia scientists. Like several of our employees, Bill Lenling had a Masters in Metallurgical engineering from the University of Wisconsin. He went to work on government projects. You might say that he was working on his apprenticeship in plasma technology at Sandia.

I have spoken about this program many many times over the past 8 or 10 years and have told numerous people that we received our graduate degree from Sandia. Where could you find a facility with the high level of scientific ability available in a production environment? Sandia actually finds solutions to real problems. We worked on some of these problems. One early problem involved a way to insulate a detonator from intense heat in the event a plane went down with an atomic weapon on board. There were numerous other programs that our engineer worked hand in hand with the Sandia scientists. Four papers were authored and presented to the various technical societies. Three in particular received a best paper award Four cover pages are **attached**. Please note the authorship includes our engineer along with Sandia personnel. These represent original work that has advanced the technology available for the entire industry which is certainly a benefit to the US economy.

Our ability to solve problems with plasma spry technology has resulted in several new products here in the US. One part is rather mundane but a product that could only be obtained from Europe, a ceramic bike rim. Ceramics provide superior braking action in wet weather. A more sophisticated product is a Bi-Polar scissors for the medical field. I have a sample for you to see. This product's success depended upon the development of a very high density alumina ceramic coating, a product that took some five years to develop. This is just now being put on the market and will provide the surgeon with a device that will cauterize the incision for bloodless surgery. Both projects are the result of the tutelage we received at Sandia. We have many other examples, such as impulse drying of paper - we are told that implemented this process would save over $1,600,000,000 per year in energy costs in the paper industry. The success of this is dependent upon a thermal sprayed ceramic coating. This is one item we initially brought to Sandia and which is now about ready for the first stage of commercialization.

While we view the program as making a significant contribution to the success of our company, we lock on it as a win win situation for both the lab and our company. We did not approach this as a freebie but as a joint effort. Our objective was to get process information. We did not come away, nor did we intend to come away with a marketable product. The government labs are the repository of some of the most important process technology in the world. As long as we have government and military needs for these kind of facilities, I believe that it is important that there be ways to disseminate the information. When you view this in the context of a learning experience and you get participation from everyone, one can justify the expense.

It does not seem feasible to be able to get private companies to be able to pay the full cost of any of the tech transfer programs. Consider that Sandia necessarily, has the best (most expensive) equipment and the cream of the scientific crop figured into its overhead. When you combine those items with the bureaucracy as a result of being funded by a government agency, the cost of getting anything done are truly exorbitant. It is easy to see why a special hammer might cost $600.

The fundamental question is whether or not the labs should continue to exist. Do we have the national concerns that justify their continued operation. If that answer is yes then we need to recognize that high cost and find a way to get the technology that is being developed at these labs into the private sector. There may be a certain animus among many scientists about sharing knowledge or perhaps being bothered or interrupted by these programs. Perhaps we should ask the lab scientists to think of themselves differently. Perhaps they should think more like those in academia where the mission is to educate and train. The labs should be mentors to private industry. This type of attitude along with the production facilities at a lab such as Sandia could go a long way toward transferring the technology into the US economy.

It is necessary to recognize that to have world class facilities that the labs overhead would be far and above that which any one other than a government agency could afford and charge accordingly. In the case of our grant, the fact that we contributed a full time post graduate engineer who worked at least 50% of his time on government projects, the government got a full return and more on its $57,000 investment the day we left the program. Our contribution to the general economy ranging up to $190 per dollar of original investment is merely the icing on the cake.

This program has not been without a serious investment on our part We provided the engineer which was more than the grant when you add on the overhead costs to it. To date our investment exceeds $1,500,000, a substantial sum for a small company such as ours. For a long time I could not find a justification for the expense on our balance sheet. We were doing a lot of interesting things with no return on our investment. It has only been recently that some of these projects are reaching the production stage and providing revenue. We are convinced that we have made a significant contribution which would not have been without our Sandia learning experience.

This is truly a success story.

Richard L. Wilkey
Attachments 1 - 4

Attachment 1 of 4

A Comparison of Techniques for the Metallographic Preparation of Thermal Sprayed Samples

M. F. Smith, D. T. McGuffin, and J. A. Henfling
Sandia National Laboratories
Albuquerque, NM

W. B. Lenling
Thermal Spray Technologies
Watertown, WI

Reprinted from
Thermal Spray Coatings:
Properties, Processes and Applications
Proceedings of the
Fourth National Thermal Spray Conference
Pittsburgh, Pennsylvania, USA
4–10 May 1991

REPRINT

ASM INTERNATIONAL
The Materials
Information Society

Attachment 2 of 4

Beneficial Effects of Austempering Post-Treatment on Tungsten Carbide Based Wear Coatings

William J. Lenling
Fisher-Barton, Inc.
Watertown, Wisconsin, USA

Mark F. Smith, Joseph A. Henfling
Sandia National Laboratories
Albuquerque, New Mexico, USA

Reprinted from
THERMAL SPRAY RESEARCH AND APPLICATIONS
Proceedings of the
3rd National Thermal Spray Conference
Long Beach, California
20–25 May 1990

REPRINT

ASM INTERNATIONAL®
The Materials Information Society

Attachment 3 of 4

Thermal Coating Development for Impulse Drying

W. J. Lenling
Thermal Spray Technologies
Division of Fisher-Barton, Inc.
Watertown, Wisconsin, USA
M.F. Smith
Sandia National Laboratories
Albuquerque, New Mexico, USA
D.I. Orloff
Institute of Paper Science and Tech.
Atlanta, Georgia, USA

Reprinted from
THERMAL SPRAY: INTERNATIONAL
ADVANCES IN COATINGS TECHNOLOGY
Proceedings of the
International Thermal Spray Conference
28 May-5 June 1992
Orlando Florida USA

REPRINT

ASM INTERNATIONAL®
The Materials
Information Society

Attachment 4 of 4

Process for Producing Plasma Sprayed Carbide-Based Coatings with Minimal Decarburization and Near Theoretical Density

William J. Lenling
Fisher-Barton, Inc.
Watertown, Wisconsin, USA

Mark F. Smith, Joseph A. Henfling
Sandia National Laboratories
Albuquerque, New Mexico, USA

Reprinted from
THERMAL SPRAY
RESEARCH AND APPLICATIONS
Proceedings of the
3rd National Thermal Spray Conference
Long Beach, California
20–25 May 1990

REPRINT

ASM
INTERNATIONAL
The Materials
Information Society

Additional material

United States General Accounting Office

GAO

Report to the Chairman, Subcommittee on Energy and Environment, Committee on Science, House of Representatives

June 1996

ENERGY RESEARCH

Opportunities Exist to Recover Federal Investment in Technology Development Projects

GAO

United States
General Accounting Office
Washington, D.C. 20548

Resources, Community, and
Economic Development Division

B-271732

June 26, 1996

The Honorable Dana Rohrabacher
Chairman, Subcommittee on Energy and Environment
Committee on Science
House of Representatives

Dear Mr. Chairman:

The Department of Energy (DOE) is involved in many cost-shared technology development programs with the private sector. In general, a major objective of such programs is to help promote the development and commercialization of more efficient, environmentally attractive, and affordable technologies that will better utilize the nation's energy resources and enhance opportunities for domestic economic growth and employment. In view of the increasing importance of using creative methods to fund technology programs under today's budgetary constraints, you requested that we (1) determine the extent to which DOE requires repayment of its investment in cost-shared technology development, including the similarities and differences in the mechanisms used, and (2) identify the advantages and disadvantages of repayment. We focused most of our work on four DOE offices—Fossil Energy, Energy Efficiency and Renewable Energy, Environmental Management, and Nuclear Energy—because they fund most of the Department's cost-shared technology development programs and projects involving contracts and cooperative agreements.

Results in Brief

DOE generally does not require repayment of its investment in cost-shared technology development projects. We identified four programs in DOE that require repayment of the federal investment if the technologies are commercialized. The offices we reviewed plan to devote about $8 billion in federal funds to cost-shared projects, of which about $2.5 billion is subject to repayment. The four programs are the (1) Clean Coal Technology Program, which accounts for about 90 percent of the funds subject to repayment; (2) Metals Initiative Program; (3) Electric Vehicles Advanced Battery Program; and (4) Advanced Light Water Reactor Program, which requires repayment for some projects.

DOE recoups its investment under all four programs through royalties and fees paid under licensing agreements. A percentage of revenues from commercial sales of technologies is also applied toward repayment in three of the programs and to a limited extent in the Advanced Battery Program. The Metals Initiative Program allows for the recovery of 150 percent of the federal investment, while the other three programs are limited to 100 percent.

The major advantage of having a repayment policy is that the federal government could recover some of its investment in successfully commercialized technologies. However, according to DOE officials, repayment could also discourage some in industry from commercializing technologies or participating in projects, create an administrative burden on both DOE and industry, and cause technologies to become less competitive in the marketplace. We believe many of the disadvantages can be mitigated by structuring a flexible repayment requirement with the disadvantages in mind. Because opportunities exist for substantial repayment in some of DOE's programs, requiring repayment would allow the government to share in the benefits of successfully commercialized technologies that could amount to hundreds of millions of dollars.

Background

DOE and the private sector are involved in hundreds of cost-shared projects aimed at developing a broad spectrum of cost-effective, energy-efficiency technologies that protect the environment; support the nation's economic competitiveness; and promote the increased use of oil, gas, coal, nuclear, and renewable energy resources. Universities and national laboratories also participate in many of these government-industry collaborations. Most of the projects that involve technology development beyond basic research are funded under cost-shared contracts, cooperative agreements, and cooperative research and development agreements (CRADAs).

The offices in our review are funding more than 500 projects under contracts and cooperative agreements with industry that are expected to cost more than $15 billion by the time they are completed. DOE plans to fund about $8 billion and industry the balance. The four programs that require repayment cover about 60 projects. The other programs cover more than 450 projects.

Four DOE Programs Have a Repayment Policy, and the Repayment Mechanisms Are Similar

Although DOE participates with the private sector in many cost-shared technology development programs, only four require repayment of the federal investment if the technology is ultimately commercialized. The mechanisms used for repayment are similar in that they generally require a portion of royalties and fees from licensing technologies and revenues from commercial sales.[1] Also, three programs provide for up to a 20-year repayment period and two allow flexibility on when repayment begins. A major difference in the programs is that one program provides for up to 150-percent repayment, while the other programs limit repayment to 100 percent.

Clean Coal Technology Program

The Clean Coal Technology Program is a partnership between the federal government and industry for sharing the costs of commercial-scale projects that demonstrate innovative technologies for using coal in a more environmentally sound, efficient, and economical manner. DOE is investing more than $2.2 billion in this program through the year 2003. The funds have been committed under cooperative agreements to more than 40 active and completed projects that were selected in five separate rounds of nationwide competitions for project proposals conducted from 1986 to 1993. DOE funds up to 50 percent of a project's cost, and the nonfederal participants fund the balance. Most of the projects are currently in the design, construction, or operation phases.

In 1985, when the program began, DOE made a programmatic decision in consultation with industry and the Congress to require the participants in the clean coal projects to repay the federal investment in projects within 20 years after a project ends if the technology is commercialized. For projects selected in the first round of competition, repayment was to come from (1) any net revenues generated from continued project operations and (2) revenues accruing from the commercial sale, lease, manufacture, licensing, or use of the technology. During rounds two and three, DOE changed the repayment provisions to respond to the industry's concerns and lessen the likelihood that the repayment requirements could hamper the project participants' competitiveness. Among other things, DOE (1) excluded net operating revenues as a required source of repayment, (2) reduced the percentage of revenues from technology sales that are subject to repayment, (3) excluded foreign sales from repayment, (4) eliminated an inflation adjustment requirement, (5) allowed a grace period before repayment begins to facilitate the technology's initial market penetration, and (6) provided for a waiver from repayment altogether if repayment would place the participants at a competitive disadvantage in the marketplace.[2]

---

[1] DOE's national laboratories and energy research centers can receive royalties and fees from licensing patents for inventions, processes, and services that are developed under cost-shared CRADAs and other mechanisms. Although the provisions covering these agreements can also constitute a form of repayment, they are designed to provide the government with a way to share in the success of a technology and are independent of the government's contribution to the underlying technology. As agreed with your office, we excluded CRADAs as a specific focus of this review because there is no transfer of federal funds to industry participants.

According to DOE officials, three clean coal projects with a federal investment of about $36.2 million have progressed to the repayment phase. As of March 1996, DOE had received payments totaling about $377,000 for these projects.

Metals Initiative Program

Under the Metals Initiative Program, DOE shares in the cost of research and development projects intended to increase the energy efficiency and enhance the competitiveness of the domestic steel, aluminum, and copper industries. The projects are carried out under cooperative agreements. Industry is required to provide at least 30 percent of the funding, and DOE provides the balance. Industry participants establish a holding company for each project for the purpose of holding patents, licensing technology, tracking technology sales and use, and collecting and distributing licensing fees and other income.

Appropriations laws require repayment of the total federal investment up to one and one-half times (150 percent) from the proceeds of the commercial sale, lease, manufacture, or use of technologies developed under the program. The Metals Initiative Program is the only program that requires repayment that exceeds DOE's investment. According to DOE, repayment applies to all sales—domestic or foreign. As of September 1995, DOE had spent or obligated about $89 million for projects under this program. Although some patent applications have been filed and some licensing agreements have been negotiated, none of the projects have begun repayment yet, according to DOE officials.

Electric Vehicles Advanced Battery Development Program

In early 1991, Chrysler, Ford, and General Motors established the United States Advanced Battery Consortium to jointly sponsor research and testing to develop advanced batteries for electric vehicles. Later that year, DOE and representatives of the utility industry agreed to work together with the consortium under a cost-sharing arrangement. DOE is providing 50 percent of the funding, and the other 50 percent is being provided by the participating automobile companies, utilities, and battery developers. According to DOE, current plans call for federal contributions amounting to about $103 million for funding this research through 1996. DOE expects to approve additional funding for the continuation of the research after the consortium submits a proposal identifying its funding needs.

---

[2] Changes in repayment provisions during the program and their potential implications are discussed in two prior GAO reports—Fossil Fuels: Lessons Learned in DOE's Clean Coal Technology Program (GAO/RCED-94-174, May 26, 1994) and Fossil Fuels: Improvements Needed in DOE's Clean Coal Technology Program (GAO/RCED-92-17, Oct. 30, 1991).

As discussed in our August 1995 report,[3] DOE is entitled to repayment of its financial contributions to the consortium if the advanced batteries are commercialized. Repayment is recommended in a Senate appropriations report. Under the terms of the cooperative agreement between DOE and the consortium, DOE's investment is to be repaid based on (1) the revenue received by the consortium or its battery developers from the licensing of patents to third-party domestic or foreign battery manufacturers and (2) any payments to the consortium or its contractors upon the liquidation or winding up of its business. In addition, one of the consortium's battery development contracts provides for repayment to DOE based on revenues from the domestic or foreign sale of batteries by the developer. The repayment period ends after DOE's total contribution has been repaid, or 20 years, whichever occurs first. The repayment obligation can be waived, in whole or in part, if DOE determines that repayment places the consortium or its battery developers at a competitive disadvantage. Three of the eight battery development contracts provide that repayment will not begin until battery sales by the developer and/or licensee reach a specified level.

Advanced Light Water Reactor Program

The reactor program focuses on making standardized advanced light water reactors available for orders during the 1990s to help meet the projected demand for new electrical generation capacity by 2010. DOE provides up to 50 percent of the funding for projects carried out with industry, and industry provides the balance. According to DOE, in 1986 when this program was begun, repayment was not considered because the main objective was to reduce the licensing and regulatory impediments that were contributing to extensive delays in the construction and permitting of nuclear power generating facilities. The objective evolved into a certification of advanced light water reactor designs to help restore the industry's confidence and reduce the financial risks in acquiring new nuclear plants at the appropriate time in the future. The repayment provisions covering domestic or foreign sales have been incorporated into two programs that are part of the Advanced Light Water Reactor Program.

---

[3] Electric Vehicles: Efforts to Complete Advanced Battery Development Will Require More Time and Funding (GAO/RCED-95-234, Aug. 17, 1995).

In one of these programs—the advanced reactor design certification program—the Congress provided $14 million in additional funding for a specific contract, and an appropriations report recommended that this additional federal cost should be repaid from royalties on the first commercial sale of the reactor design. DOE will require repayment of this amount. DOE subsequently agreed to provide another $11 million in additional funding and may require that this amount be repaid, as well as any additional future funding provided under this contract. DOE's original contractual commitment of about $50 million is not subject to repayment. According to DOE officials, the Department also may provide for the recovery of any federal contributions in excess of the original $50 million commitment under another contract in the advanced reactor design certification program.

The other program—the "first-of-a-kind" engineering program—involves a cooperative agreement between DOE and the Advanced Reactor Corporation. According to DOE, in the development of this program, the participating electric generating utilities made a major commitment to provide cost-share funding and overall direction and technical advice to achieve a plant design that they would be willing to acquire at some future time. Because of their direct, substantial contributions to the plant designs, the utilities require reactor vendors to pay them royalties from the sale of the plant designs or technology to other customers. Since the utilities were going to require royalty payments, DOE decided to also require royalties proportionate to its share of the project's total costs. The cooperative agreement requires that DOE be repaid up to its total investment from the revenues received by the Advanced Reactor Corporation from the sale or use of the plant designs or technology developed under this program. The repayment period runs up to 20 years, or until the federal investment, which is expected to total $100 million, is repaid.

Advantages and Disadvantages of a Repayment Policy

A repayment policy provides both advantages and disadvantages. The main advantage is the recovery of the federal investment. We believe that many of the disadvantages and arguments against repayment can be mitigated by structuring a flexible policy that provides criteria and factors to consider in determining the application of repayment to individual programs or projects.

In 1991, DOE considered having a Department-wide policy to recover its investment in technology development projects and even developed a draft order with criteria and guidelines for determining when repayment is appropriate. But due to substantial opposition within the Department and the departure of the Deputy Secretary who was the primary supporter of this concept, the order was never implemented.

Advantages

The primary advantage of a repayment policy is that the government could recover some of its investment in the development of technologies. According to several DOE officials, a repayment requirement could also provide more assurance that the project proposals are sound and economically viable by discouraging proposals that are too marginal financially for their sponsors to commit to repayment.

As previously mentioned, the DOE offices in our review are funding projects with industry that are expected to cost more than $15 billion by the time they are completed. DOE's share of the planned funding is expected to total about $8 billion, and the nonfederal share about $7 billion, as shown in table 1. About $2.5 billion of the $8 billion is subject to repayment.

Table 1: Total Planned Funding for Cost-Shared Technology Development Projects Involving Contracts and Cooperative Agreements Within Four DOE Offices

Dollars in millions

	DOE's share				
Office	**Amount subject to repayment**	**Amount not subject to repayment**	**Total DOE planned funding**	**Nonfederal share**	**Total DOE and nonfederal share**
Fossil Energy	$2,232.3	$4,337.5	$6,569.8	$5,249.0	$11,818.8
Energy Efficiency and Renewable Energy	144.9	838.3	983.2	1,259.0	2,242.2
Environmental Management	0.0	46.3	46.3	18.0	64.3
Nuclear Energy	114.0	267.9	381.9	595.2	977.1
Total contracts and cooperative agreements	**$2,491.2**	**$5,490.0**	**$7,981.2**	**$7,121.2**	**$15,102.4**

Note: The amounts are in nominal dollars and represent the total funds spent and planned for active projects. DOE spent about $60.9 million for completed or terminated projects under the Metals Initiative Program.

Source: Prepared by GAO using DOE's data.

Except for the projects within the four programs that already require repayment, it is important to note that, for a variety of reasons discussed later, not all of the projects contained in the table would lend themselves to repayment. In addition, unless follow-on projects are undertaken, requiring new or amended contracts or cooperative agreements, only new projects not yet negotiated with industry would be appropriate for repayment.

While the potential repayment is difficult to quantify, DOE documents developed when the 1991 draft repayment policy statement was under consideration indicated that the potential is substantial. To illustrate the potential for repayment, we subtracted the approximately $2.5 billion in federal funding included in table 1 for projects already covered by repayment provisions from the approximately $8 billion total planned federal funding. The remaining cooperative agreements and contracts amount to about $5.5 billion. If one assumes that only 50 percent of this amount is dedicated to projects that would lend themselves to repayment, and that about 15 percent of research and development funds result in commercialized technologies (which DOE officials say is about average), then about $400 million could come back to the federal government in the form of repayment.

In discussing technology development programs and projects with DOE's Deputy Assistant Secretaries and other DOE officials, many of them agreed that certain types of projects might be appropriate candidates for repayment of the federal investment if the concept was employed at the beginning of the projects or new projects are undertaken in the future. The officials generally indicated that repayment should be more applicable to projects with a large federal investment where the federal contribution is easily identified, projects involving technologies that are close to commercialization, and projects in which the federal investment serves to reduce the costs and risks of providing the technology to potential users. The officials also said that technologies that have a large potential market and technologies that are likely to be commercialized in foreign countries are good candidates for requiring repayment of the federal investment. Some officials said that repayment should be directed at projects that have large, well-financed industry teams.

DOE officials indicated, for example, that the Reservoir Class Field Demonstration Program might be appropriate for repayment if future projects are undertaken. This program shares costs for demonstrations of existing and new technologies for increasing production from U.S. oil fields that might otherwise be prematurely abandoned. The program operates on the premise that the characteristics of some oil formations are similar, and when small and major oil producers demonstrate technologies and processes that are successful in increasing production, other oil field operators may want to try them in their fields. Three rounds of demonstration projects have been undertaken, and more may be undertaken if funding becomes available. DOE has committed about $100 million to the 29 projects that are currently in the program. According to DOE, the projects may take from 3 to 7 years to complete.

The Advanced Turbine Systems Program is another program that DOE officials said might be appropriate for repayment if new projects are begun or current projects are amended. This program is intended to develop more efficient, advanced turbine systems for both utility and industrial electric power generation. According to DOE, the program is expected to cost about $700 million by the time it is completed in the year 2000. Depending on appropriations, DOE is planning to fund about $450 million of the total estimated cost, and industry participants are expected to fund the balance.

New cost-shared technology demonstration and commercial application programs authorized by the Energy Policy Act of 1992 would also be appropriate candidates for repayment if they are funded. In fact, the act requires DOE to establish procedures and criteria for the repayment of the federal investment in several authorized coal projects, but they have not been funded.

Many of the DOE officials we spoke with generally indicated a willingness to consider repayment, but they said that flexibility should exist to be able to structure or waive repayment to meet programmatic needs. Some officials believed that repayment may not be suitable for grants, universities, and small businesses or for projects that are directed at basic research. Others indicated that repayment should be waived if the federal investment is considered disproportionately small in comparison with the potential costs of administering the repayment process. Some DOE officials said that a stronger argument can be made for repayment if the technology developed is likely to be commercialized outside of the United States.

Appendix I provides a more detailed discussion of the types of projects that DOE officials believe would be the most appropriate or suitable for repaying the federal investment.

Disadvantages

DOE officials we spoke with and DOE's 1991 draft document on repayment policy also pointed out several disadvantages to the government or industry participants that would need to be addressed. These disadvantages, along with potential ways to structure repayment so as to mitigate the disadvantages, are discussed below.

According to DOE, most technologies funded by the Department require further development and/or funding to bring them to the marketplace after DOE's participation is complete. Some DOE officials believe that repayment could lower industry's rate of return on investment and discourage industry, especially small businesses, from commercializing such technologies. The officials also believe that repayment might discourage industry from participating in cost-shared technology development projects in technological areas that DOE wants to promote. In our October 1991 report, we recommended that DOE study the effect that repayment provisions have had on the industry's participation in the Clean Coal Technology Program. DOE agreed to do this but has not completed its study. Although a repayment requirement might have some influence on the timing of commercialization or participation in technology development projects, industry participants would not have to repay the federal investment unless the technology is commercialized. Therefore, repayment should be more favorable to industry than other sources of funding, such as a bank loan, which would have to be repaid with interest regardless of whether the technology is commercialized. According to a former DOE Deputy Secretary who supported the expansion of repayment programs, businesses expect some form of repayment as a normal cost of doing business.

DOE officials generally believe that repayment would create an administrative burden in negotiating, administering, auditing, and enforcing cost-sharing and repayment agreements. Both DOE and industry participants would need to establish a recordkeeping system for tracking the sales and use of technologies long after a project ends (up to 20 years in three of the programs that require repayment). According to DOE, the administrative and auditing costs may not make it worthwhile to pursue repayment. We believe one way of making the administrative burden less onerous and minimizing auditing requirements might be to require sample audits of industry participants' records. Another approach might be to require repayment only in those instances in which the amount of the return justifies the cost of necessary audits and other internal control measures. DOE officials indicated that they are studying the issue of ensuring proper repayment in the Clean Coal Technology Program.

Many DOE officials believe that obtaining increased cost-sharing by industry is preferable to requiring repayment of the federal investment. Some indicated that a repayment requirement could be used as a negotiating tool to obtain higher cost-sharing in lieu of repayment. The officials also argue that it may be better in terms of conserving federal resources to obtain an increased cost-share from all participants than to obtain repayment only from those successfully commercializing their technologies.

According to DOE, any repayment provisions must consider the effect of repayment on the ability of the entity carrying out the project to compete in the marketplace (proceed with commercialization of the technology and achieve a rate of return commensurate with the industry and the risk). DOE believes that if repayment obligations are too demanding, especially in the early years of technology sales, cash flows and profitability may not be sufficient for the organization responsible for repayment to remain in business, or licensing fees and costs may be too high for the technology to remain competitive with alternative technologies. We believe one way of mitigating this concern could be to allow a grace period after a project ends before requiring repayment to begin, as was done in two of the programs discussed above that require repayment. A grace period could be based on a specified period of elapsed time or a specified number of technology units sold before repayment begins.

Other Related Issue

Another issue is the disposition or use of the proceeds resulting from repayment. Many DOE officials indicated that any proceeds from repayment programs should flow back into the applicable program to leverage the federal funding that would be available for ongoing and future projects, rather than be deposited in the Treasury, which is the current practice. Under current policy, proceeds are available to either reduce the budget deficit or to be reallocated on the basis of national priorities.

Conclusions

While we do not believe that cost recovery should be a major objective, opportunities may exist for substantial recovery of taxpayers' dollars if DOE would adopt a policy to require repayment of its investment in successfully commercialized technologies. However, a repayment policy would need to be structured with enough flexibility so as not to interfere with program objectives or adversely affect industry's participation in projects and technology commercialization. Such a policy should provide criteria and factors to consider in determining whether it should be applied to individual programs or projects. A properly structured policy could provide the flexibility needed to mitigate many of the arguments against having a policy.

Recommendation

We recommend that the Secretary of Energy develop and implement a Department-wide policy for requiring repayment of the federal investment in successfully commercialized cost-shared technologies. The policy should provide criteria and flexibility for determining which programs and projects are appropriate for repayment.

Agency Comments and Our Response

We provided a draft of this report to DOE for its review and comments. DOE said that it concurred with our conclusion that cost recovery should not be a major objective of a federal technology development program but pointed out that in its experience, there are individual projects and programs for which repayment provisions can work. DOE said that demonstration programs that are well advanced in the research and development pipeline are the most likely candidates for repayment. According to DOE, however, the real payback to the nation is in the societal benefits that flow out of federally funded research and development, including jobs, competitiveness in world markets for U.S. companies, and the resulting contributions to the U.S. economy of both domestic and export technology sales. We agree that these potential benefits are very important, but they are independent of the argument for recovering the taxpayers' share of investment in successfully commercialized technologies. If repayment under appropriate circumstances was an ancillary requirement for successfully commercialized technologies, it would allow the government to potentially recover some of its investment in technologies as well as enjoy the other positive benefits that might accrue.

In the case of environmental cleanup technologies, DOE said that the payback is in the form of cost avoidance to the government through the use of innovative technologies that reduce the cost of cleaning up the contaminated weapons complex. We recognized this major benefit in our draft report. However, we continue to believe that if such technologies have potential commercial application, new projects demonstrating the technologies should be considered for repayment of the federal investment.

DOE said that it agreed with our recommendation that a repayment policy should provide the flexibility for determining which programs and projects are appropriate for repayment. DOE believes that the policy should also have flexibility in determining the repayment terms, and when and how they should be applied so as not to adversely affect the development or introduction of technologies into the marketplace.

Appendix II contains the complete text of DOE's comments, along with our responses.

Our work was performed from August 1995 through April 1996 in accordance with generally accepted government auditing standards. Appendix III describes the scope and methodology of our review.

As arranged with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 15 days after the date of this letter. At that time, we will provide copies to the Secretary of Energy, appropriate congressional committees, and other interested parties. We will also make copies available to others upon request.

Please contact me at (202) 512-3841 if you have any questions or need additional information. Major contributors to this report are listed in appendix IV.

Sincerely yours,

Victor S. Rezendes
Director, Energy, Resources,
and Science Issues

Contents

Letter 1

Appendix I Potential Repayment in DOE Cost-Shared Programs 16
Fossil Energy Programs 16
Energy Efficiency and Renewable Energy Programs 18
Environmental Management Programs 21
Nuclear Energy Programs 22

Appendix II Comments From the Department of Energy 24
GAO's Comments 27

Appendix III Scope and Methodology 28

Appendix IV Major Contributors to This Report 29

Related GAO Products 32

Tables
Table 1: Total Planned Funding for Cost-Shared Technology Development Projects Involving Contracts and Cooperative Agreements Within Four DOE Offices 7
Table I.1: Planned Funding for Fossil Energy Cost-Shared Technology Development Projects 17
Table I.2: Planned Funding for Energy Efficiency and Renewable Energy Cost-Shared Technology Development Projects 19
Table I.3: Planned Funding for Environmental Management Cost-Shared Technology Development Projects 21
Table I.4: Planned Funding for Nuclear Energy Cost-Shared Technology Development Projects 23

Abbreviations

CRADAs	cooperative research and development agreements
DOE	Department of Energy
GAO	General Accounting Office

Appendix I

Potential Repayment in DOE Cost-Shared Programs

This appendix discusses the Department of Energy's (DOE) cost-shared technology development programs administered under four major organizational areas—Fossil Energy, Energy Efficiency and Renewable Energy, Environmental Management, and Nuclear Energy. The appendix also summarizes the planned funding for technology development projects in each of the four areas and discusses the views of DOE officials on the types of programs and projects that would be the most appropriate or suitable for repayment of the federal investment.[4]

Fossil Energy Programs

DOE's fossil energy technology development programs support cost-shared projects with industry to foster the development and commercialization of coal, petroleum, and natural gas technologies. As shown in table I.1, DOE's planned funding for coal and special technology projects accounts for the largest portion, by far, of the nearly $6.6 billion that DOE is planning to invest in active fossil energy projects. More than $2.2 billion is committed to projects in the Clean Coal Technology Program, which requires repayment if the technologies are commercialized. Other large DOE investments in coal and special technology projects involve programs that are developing fuel cells, advanced turbine systems, and advanced pulverized coal systems.

DOE's Reservoir Class Field Demonstration Program accounts for about 90 percent of the Department's planned funding for cost-shared petroleum technology projects. This program demonstrates technologies and processes for increasing production from oil fields to prevent them from being prematurely abandoned. Natural gas technology projects focus on new and improved technologies for extracting, delivering, storing, and using natural gas.

---

[4] In this appendix, we use the term planned funding to include the total funds spent and planned for active technology development projects.

Table I.1: Planned Funding for Fossil Energy Cost-Shared Technology Development Projects

Dollars in millions

	DOE's share	Nonfederal share	Total
Coal and special technology projects			
Contracts	$853.0	$278.0	$1,131.0
Cooperative agreements	5,542.6	4,739.9	10,282.5
Petroleum projects			
Contracts	11.3	9.4	20.7
Cooperative agreements	100.1	133.6	233.7
Natural gas projects			
Contracts	34.0	52.8	86.8
Cooperative agreements	28.8	35.3	64.1
Total contracts	898.3	340.2	1,238.5
Total cooperative agreements	5,671.5	4,908.8	10,580.3
Total	**$6,569.8**	**$5,249.0**	**$11,818.8**

Source: Prepared by GAO using DOE data.

According to DOE officials in the fossil energy area, several fossil energy technology development programs may be appropriate candidates for repayment if new or amended projects are undertaken. Two of them—the Reservoir Class Field Demonstration Program and the Advanced Turbine Systems Program—have previously been discussed. According to the officials, the Fuel Cell Program might also be a possible candidate for repayment if DOE decides to help fund the costs and risks of providing fuel cell technology to potential users. DOE is planning to invest about $270 million through completion of active cooperative agreements to develop new, improved fuel cells for power generation. The officials indicated that the fuel cell industry is an infant industry, and the vision of the program is to enable the U.S. fuel cell industry to be strongly competitive in the international market after the year 2000.

According to DOE officials, the Advanced Pulverized Coal Program could also be a candidate for repayment as additional federal investment is committed to new projects. Under one aspect of this program, separate teams of industry partners are developing a conceptual design for a 400-megawatt power plant based on pulverized coal-firing technology incorporating advanced boiler design and innovative pollution control systems. DOE will then select one of the teams to develop and produce a module to test and confirm the performance of that team's technology concept, which will serve as a prototype unit. DOE estimates that the entire effort will cost about $85 million, with DOE funding about 65 percent of the costs and industry funding the balance.

Regarding the natural gas projects, DOE officials said that the Gas-to-Liquids Conversion Program might be a likely future candidate for a repayment policy. The objectives of this program are to develop technologies for economic conversion of methane and other light hydrocarbon gases to liquids that can be used as clean-burning, alternative liquid transportation fuels or chemical feedstocks. DOE hopes that such technologies could one day make remote or low-quality gas supplies economical to produce and transport high-value liquids for use in petroleum and petrochemical markets.

DOE's Deputy Assistant Secretary for Gas and Petroleum Technologies told us that the potential for repayment of DOE's cost-share would be a key consideration in future gas and petroleum technology development program activities. However, the official said that funds may not be available for cost-sharing additional rounds of projects under the Reservoir Class Field Demonstration Program.

Energy Efficiency and Renewable Energy Programs

DOE's energy efficiency and renewable energy cost-shared technology development programs support projects conducted jointly with industry to develop advanced technologies for use in the transportation, utility, industrial, and building sectors of the economy. These programs cover a broad spectrum of activities, ranging from research and development to demonstration and deployment. Table I.2 shows the planned funding for active projects in each sector.

Table I.2: Planned Funding for Energy Efficiency and Renewable Energy Cost-Shared Technology Development Projects

Dollars in millions

	DOE's share	Nonfederal share	Total
Transportation projects			
Contracts	$259.2	$66.9	$326.1
Cooperative agreements	103.0	103.0	206.0
Utility projects			
Contracts	129.4	164.7	294.1
Cooperative agreements	133.3	384.2	517.5
Industrial projects			
Contracts	114.9	52.4	167.3
Cooperative agreements	225.5	168.3	393.8
Building projects			
Contracts	9.9	14.0	23.9
Cooperative agreements	8.0	305.5	313.5
Total contracts	513.4	298.0	811.4
Total cooperative agreements	469.8	981.0	1,430.8
Total	**$983.2**	**$1,259.0**	**$2,242.2**

Source: Prepared by GAO using DOE data.

Transportation technology programs are directed at developing and demonstrating advanced electric and hybrid propulsion systems, advanced propulsion system materials and other new light-weight transportation materials, and advanced light- and heavy-duty heat engines. Projects support a wide range of activities, including the development of advanced batteries for powering electric vehicles, fuel cell propulsion systems, improved energy storage technologies, high-efficiency turbine engine technologies, improved automotive piston engine technologies, clean diesel engine technologies, and alternative fueled vehicles.

Utility technology programs are directed at developing and demonstrating cost-effective and energy efficiency technologies for generating electric power from geothermal, solar thermal, biomass, photovoltaics, wind, hydroelectric, and other renewable resources. Projects are also directed at increasing the efficiency and reliability of energy storage and delivery systems.

DOE supports a wide range of industrial-related projects in collaboration with the private sector to help industry develop and deploy advanced energy efficiency, renewable energy, and pollution-prevention technologies for industrial applications. The Department focuses on seven manufacturing industries that account for over 80 percent of the energy used and wastes produced by the manufacturing sector. These industries include aluminum, chemicals, forest products, glass, metalcasting, petroleum refining, and steel. According to an October 1995 DOE report,[5] over 70 of the more than 350 industrial-related projects supported by DOE in the past 20 years have resulted in commercialized technologies.

DOE also develops and promotes advanced, cost-effective, energy efficient, and renewable energy technologies for commercial and residential buildings, appliances, and building equipment. The building systems program involves research, development, and deployment activities that enable building owners and developers to capture significant energy savings opportunities by combining research on optimal systems designs with programs that deploy these energy efficiency strategies in the construction of new buildings and retrofit of existing buildings.

According to DOE's Deputy Assistant Secretary for Transportation Technologies, several projects administered by his office could have been candidates for repayment if the concept had been required at the beginning of the projects. He indicated, for example, that repayment may be appropriate in the hybrid vehicle development program where the federal investment is large and major companies are involved. He also identified some other examples involving projects to develop advanced materials, reduce manufacturing costs, or improve fuel economy. He pointed out that if technologies are relatively close to commercialization, or if the government is planning to undertake a program to reduce the costs and risks of deployment, it would be easier to support repayment with the private sector and make it work. He also indicated that repayment might be appropriate if follow-on development projects are undertaken for some technologies and the federal investment is easily identified.

The Deputy Assistant Secretary for Utility Technologies said that the most appropriate candidates for repayment for projects that his office administers are those involving plant-scale operations, such as the Solar 2 plant, geothermal facilities, wind plants, and biomass gasifier plants. He indicated that the next most appropriate candidates would be projects that are developing stand-alone systems components, such as prototype generators, advanced wind turbines, and dish Sterling solar units. He said his third choice would be manufacturing assistance programs.

---

[5] Impacts. Summary of Results from Programs Conducted by the Office of Industrial Technologies (DOE, Oct. 1995).

The Deputy Assistant Secretary for Industrial Technologies said that most of the industrial technologies could be considered likely candidates for repayment. We were told that while many of the industrial projects involve large manufacturing companies, many highly specialized, smaller firms are also typically involved as partners in these projects. However, the Metals Initiative Program is the only program that requires repayment for projects that the Deputy Assistant Secretary's office administers. As previously mentioned, repayment in that program is legislatively mandated.

Environmental Management Programs

DOE's environmental management technology development program provides new or improved methods for use in cleaning up DOE's sites across the United States that have been contaminated from decades of weapons production activities. According to DOE, these methods either reduce risks to workers, the public, or the environment; reduce cleanup costs; or provide a problem solution that currently does not exist.

Under this program, DOE and the private sector undertake cost- shared projects to demonstrate the capability of industry technologies and methods for cleaning up contamination at DOE sites. The projects generally involve development, validation, testing, and evaluation of the technologies and methods. If the technologies are proven successful, both DOE and industry benefit. Table I.3 shows the planned funding for active projects.

Table I.3: Planned Funding for Environmental Management Cost-Shared Technology Development Projects

Dollars in millions

	DOE's share	Nonfederal share	Total
Environmental management projects			
Contracts	$36.1	$13.7	$49.8
Cooperative agreements	10.2	4.3	14.5
Total	**$46.3**	**$18.0**	**$64.3**

Source: Prepared by GAO using DOE data.

According to DOE program officials, the Department does not require repayment of its investment in environmental management projects because most of the technologies or processes have already had significant expenditures by the private sector in the development phase before the industry partners entered into cooperative work with the government. DOE also expects significant savings under the environmental management technology development program through the use of the technologies or processes at cleanup sites.[6] We were told, for example, that the dynamic underground stripping process removes petroleum from groundwater 40 times faster than conventional methods. According to DOE, using this improved process, which cost $13.8 million to develop, saved taxpayers $19 million in fiscal year 1994 at one cleanup site alone.

DOE program officials agreed that some of the processes under development in their cost-shared projects may have potential commercial application. The officials also agreed that if the technologies or processes have commercial potential, they could have been candidates for repayment of the federal investment. But, the officials indicated that any such repayment would be small in comparison with the potential cost avoidance savings that are expected from using successfully demonstrated technologies or processes to cleanup DOE sites.

Nuclear Energy Programs

DOE's Office of Nuclear Energy administers the Advanced Light Water Reactor Program under cost-shared partnerships with industry. This program is intended to eliminate barriers to efficient and cost-effective operation of nuclear powerplants and maintain standards of safety in their design and operation. The program's primary focus is to make standardized advanced reactors available in time to help meet projected future power generation needs. The planned funding for light water reactors is shown in table I.4

---

[6] "Savings" here is defined as estimated reduction in DOE costs. Budgetary savings would only result if the Congress captured these cost reductions by reducing appropriations and lowering the discretionary spending caps.

Table I.4: Planned Funding for Nuclear Energy Cost-Shared Technology Development Projects

Dollars in millions

	DOE's share	Nonfederal share	Total
Light water reactor projects			
Contracts	$281.9	$431.2	$713.1
Cooperative agreements	100.0	164.0	264.0
Total	**$381.9**	**$595.2**	**$977.1**

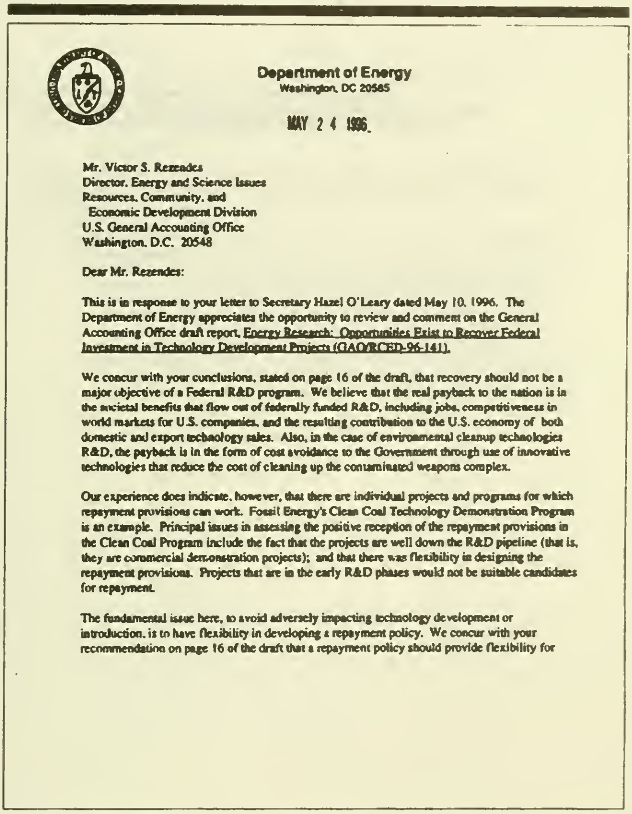
Source: Prepared by GAO using DOE data.

The overall program involves three major components: a design certification program for advanced reactors, a first-of-a-kind engineering program for advanced reactors, and a program to extend the life of aging commercial nuclear powerplants. Four cost-shared projects are being funded under separate contracts to design, test, and obtain Nuclear Regulatory Commission certification of advanced reactor designs. Two other projects are being funded under a cooperative agreement to develop the detailed engineering design of two advanced reactors in order to promote commercial standardization, produce reliable construction schedules and cost estimates, and facilitate construction preparations. Additional projects are developing technologies for assessing material degradation of systems and components at operating nuclear powerplants.

As previously discussed, DOE may require repayment of any additional federal funds provided in excess of $50 million under two of the contracts in the design certification program. According to DOE, the contractors have agreed to this arrangement. DOE requires repayment of its total investment under the cooperative agreement in the first-of-a-kind engineering program. DOE officials said that they were also looking for opportunities for DOE to share in any patents that may be developed based on technologies developed under the commercial operating reactors program.

Comments From the Department of Energy

Note: GAO comments supplementing those in the report text appear at the end of this appendix.



Department of Energy
Washington, DC 20585

MAY 24 1996

Mr. Victor S. Rezendes
Director, Energy and Science Issues
Resources, Community, and
Economic Development Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Rezendes:

This is in response to your letter to Secretary Hazel O'Leary dated May 10, 1996. The Department of Energy appreciates the opportunity to review and comment on the General Accounting Office draft report, Energy Research: Opportunities Exist to Recover Federal Investment in Technology Development Projects (GAO/RCED-96-141).

See comment 1.

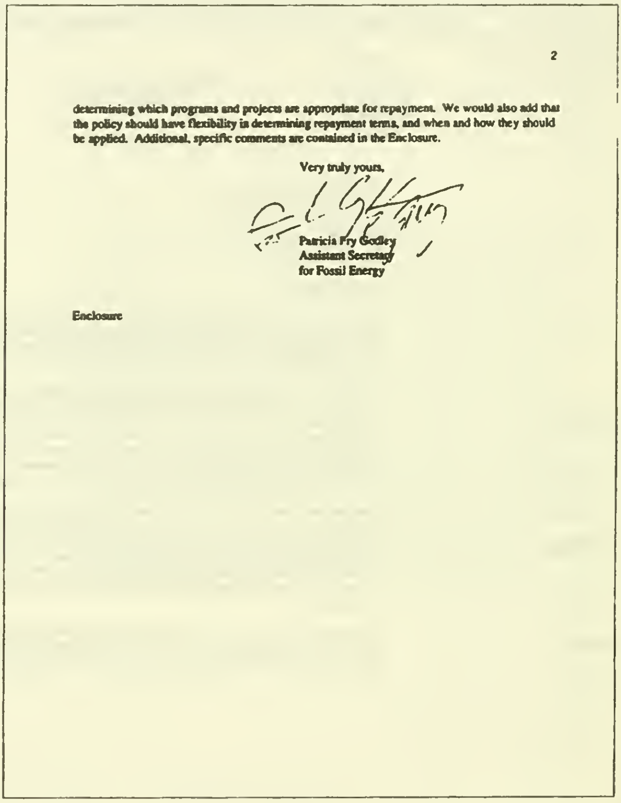
We concur with your conclusions, stated on page 16 of the draft, that recovery should not be a major objective of a Federal R&D program. We believe that the real payback to the nation is in the societal benefits that flow out of federally funded R&D, including jobs, competitiveness in world markets for U.S. companies, and the resulting contribution to the U.S. economy of both domestic and export technology sales. Also, in the case of environmental cleanup technologies R&D, the payback is in the form of cost avoidance to the Government through use of innovative technologies that reduce the cost of cleaning up the contaminated weapons complex.

See comment 1.

Our experience does indicate, however, that there are individual projects and programs for which repayment provisions can work. Fossil Energy's Clean Coal Technology Demonstration Program is an example. Principal issues in assessing the positive reception of the repayment provisions in the Clean Coal Program include the fact that the projects are well down the R&D pipeline (that is, they are commercial demonstration projects); and that there was flexibility in designing the repayment provisions. Projects that are in the early R&D phases would not be suitable candidates for repayment.

See comment 1.

The fundamental issue here, to avoid adversely impacting technology development or introduction, is to have flexibility in developing a repayment policy. We concur with your recommendation on page 16 of the draft that a repayment policy should provide flexibility for

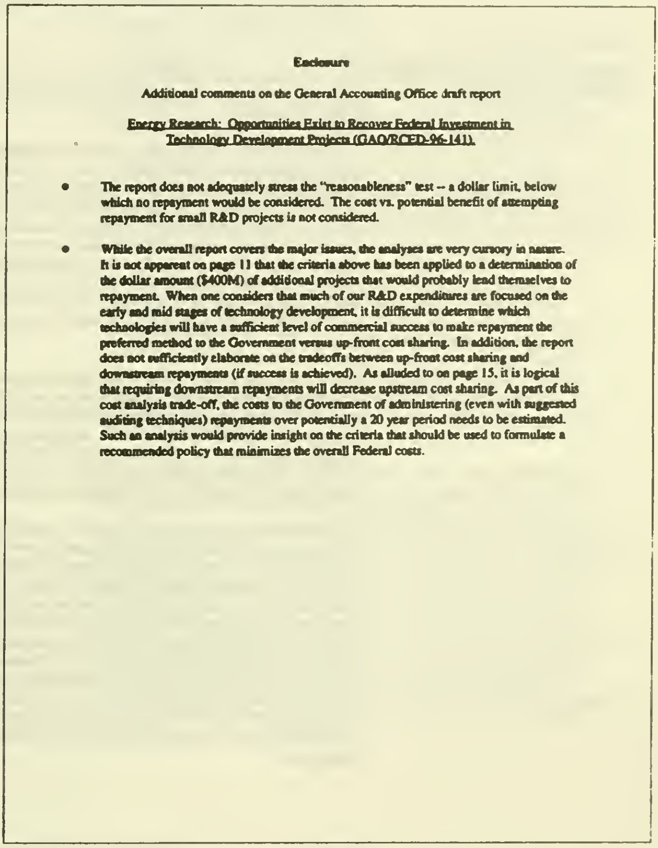


determining which programs and projects are appropriate for repayment. We would also add that the policy should have flexibility in determining repayment terms, and when and how they should be applied. Additional, specific comments are contained in the Enclosure.

Very truly yours,

Patricia Fry Godley
Assistant Secretary
for Fossil Energy

Enclosure



Enclosure

Additional comments on the General Accounting Office draft report

Energy Research: Opportunities Exist to Recover Federal Investment in Technology Development Projects (GAO/RCED-96-141).

See comment 2.

- The report does not adequately stress the "reasonableness" test -- a dollar limit, below which no repayment would be considered. The cost vs. potential benefit of attempting repayment for small R&D projects is not considered.

See comment 3.

- While the overall report covers the major issues, the analyses are very cursory in nature. It is not apparent on page 11 that the criteria above has been applied to a determination of the dollar amount ($400M) of additional projects that would probably lend themselves to repayment. When one considers that much of our R&D expenditures are focused on the early and mid stages of technology development, it is difficult to determine which technologies will have a sufficient level of commercial success to make repayment the preferred method to the Government versus up-front cost sharing. In addition, the report does not sufficiently elaborate on the tradeoffs between up-front cost sharing and downstream repayments (if success is achieved). As alluded to on page 15, it is logical that requiring downstream repayments will decrease upstream cost sharing. As part of this cost analysis trade-off, the costs to the Government of administering (even with suggested auditing techniques) repayments over potentially a 20 year period needs to be estimated. Such an analysis would provide insight on the criteria that should be used to formulate a recommended policy that minimizes the overall Federal costs.

The following are GAO's comments on the Department of Energy's letter dated May 24, 1996.

GAO's Comments

1. The issues raised in DOE's letter are addressed in the agency comments section of our report. The issues in the enclosure to DOE's letter are addressed below.

2. Our report points out that the costs of administering, auditing, and enforcing repayment agreements should be considered in determining whether to pursue repayment on specific projects. In fact, we suggested that DOE should only require repayment in those instances where the amount of the potential return justifies the cost of necessary audits and other internal control measures. We also pointed out that there may be ways to reduce the cost of such control measures, but it was beyond the scope of this review to design such measures. Once cost-effective control measures are developed, DOE could then address the related costs on a case-by-case basis in determining whether to apply repayment to specific projects.

3. Our hypothetical example of potential repayment if future projects are funded at the level planned for active projects is for illustrative purposes only. We included an assumption that half of the projects may not lend themselves to repayment. Projects in which the potential costs of obtaining repayment would exceed the potential benefits would fall in this category, along with projects that are too early in the technology development process to lend themselves to repayment.

We disagree with DOE's comment that our report does not sufficiently elaborate on the tradeoffs between up-front cost-sharing and downstream repayments if the technologies are commercialized. We pointed out that DOE generally prefers to have increased industry cost-sharing, and that some DOE officials believe that it may be better to obtain increased cost-sharing from all participants than to obtain repayment only from those that successfully commercialize their technologies. We believe that even with increased industry cost-sharing, however, an argument can be made that taxpayers have an interest in the repayment of taxpayers' dollars when technologies developed with federal funds are successfully commercialized. See comment 2 for our response to DOE's point that administrative costs should be considered in deciding whether to require repayment.

Scope and Methodology

To determine the extent to which the Department of Energy (DOE) requires repayment of its investment under cost-shared technology development and demonstration programs, including the similarities and differences in the mechanisms used for repayment, we interviewed DOE officials responsible for administering such programs; reviewed DOE reports and program documents, congressional budget requests, relevant legislation and congressional reports, and various private sector reports and publications that discuss the programs; and drew from our past reviews and reports on such programs. We also talked with several DOE attorneys, an official of DOE's Office of Inspector General, and a former congressional subcommittee staff member who had been responsible for appropriations for many DOE technology development programs.

To identify advantages and disadvantages of having or not having a repayment policy, we interviewed many DOE officials involved in administering cost-shared technology development and demonstration programs, including several Deputy Assistant Secretaries; DOE policy officials and attorneys; and a former Deputy Secretary of DOE and his former Executive Assistant. We also reviewed DOE reports and other documents that discussed the advantages and disadvantages of a repayment policy, including DOE files relating to a 1991 draft repayment policy that was never implemented.

To obtain a perspective on DOE's investment in technology development projects, we asked DOE to provide us with information on the estimated total federal and nonfederal funding planned for active cost-shared technology development projects funded under contracts and cooperative agreements. We focused on the major organizational areas of DOE that fund most of the Department's cost-shared technology development projects involving contracts and cooperative agreements—Fossil Energy, Energy Efficiency and Renewable Energy, Environmental Management, and Nuclear Energy—and we asked DOE to exclude any projects involving grants and basic research. We used the DOE information in our discussions with DOE officials to obtain their views on the types of programs and projects that might be appropriate for repayment if future projects are undertaken. We also used the information to illustrate what the repayment potential might be if DOE had a repayment policy and future projects are undertaken.

Appendix IV

Major Contributors to This Report

Resources, Community, and Economic Development Division, Washington, D.C.	Bernice Steinhardt, Associate Director Gregg A. Fisher, Assistant Director Marcus R. Clark, Jr., Senior Evaluator Joseph A. Maranto, Senior Evaluator
Office of the General Counsel	Jackie A. Goff, Senior Attorney

Related GAO Products

Electric Vehicles: Efforts to Complete Advanced Battery Development Will Require More Time and Funding (GAO/RCED-95-234, Aug. 17, 1995).

Fossil Fuels: Lessons Learned in DOE's Clean Coal Technology Program (GAO/RCED-94-174, May 26, 1994).

Fossil Fuels: Improvements Needed in DOE's Clean Coal Technology Program (GAO/RCED-92-17, Oct. 30, 1991).

DOE/IG-0391

U.S. Department of Energy
Office of Inspector General

June 1996

Report on

Audit of Department of Energy's Activities Designed to Recover the Taxpayers' Investment in the Clean Coal Technology Program

RECEIVED
JUN 28 1996
Committee on Science

United States Government Department of Energy

memorandum

DATE: June 6, 1996

REPLY TO ATTN OF: IG-1

SUBJECT: INFORMATION: Report on "Audit of Department of Energy's Activities Designed to Recover the Taxpayers' Investment in the Clean Coal Technology Program"

TO: The Secretary

BACKGROUND:

In 1985, the Congress directed the Department of Energy to implement a Clean Coal Technology Program. The purpose of this Departmental initiative is to successfully demonstrate a new generation of advanced coal-based technologies. As a part of the program, the Department established a goal to recover an amount up to the taxpayers' investment in each successfully commercialized clean coal technology project. The objectives of the audit were to determine whether clean coal recoupment practices are achieving the Department's goal of recovering the taxpayers' investment in successfully commercialized projects and the impact of these practices on future Departmental recoupment efforts.

DISCUSSION:

As of December 31, 1995, the clean coal program included 42 projects with repayment agreements predicated on the successful commercialization of demonstrated technologies. The Department's cost share for these projects was approximately $2.3 billion. A detailed analysis of six clean coal projects revealed that recoupment decisions made by the Department limited its ability to recover the taxpayers' investment. These decisions exempted foreign sales, excluded some domestic sales on certain projects, and lowered the repayment rate on some sales. As a result, the Department may not recoup an estimated $133.7 million of the taxpayers' $151 million investment in these six projects and may limit its opportunity to recover future investments in other energy technology programs. An analysis and justification of recoupment decisions would help ensure that the Department is balancing overall program goals of the clean coal program with their recoupment goal. Analysis and justification of recoupment decisions would also facilitate implementation of future Departmental technology transfer programs. These programs are required by the Energy Policy Act of 1992 to model their recoupment procedures after those of the Clean Coal Technology Program.

Formal financial policies and procedures also had not been established to track, account for, and verify the accuracy of moneys due and collected from industry participants. Repayment policies and procedures would help ensure that the Department collects moneys from successfully commercialized clean coal projects.

The Deputy Assistant Secretary for Coal Technology, the Deputy Controller, and the Directors, Pittsburgh and Morgantown Energy Technology Centers, agreed with the report's recommendations. However, the Deputy Assistant Secretary cautioned that the greatest payback to the nation from the program will not be in the form of repayment of Federal cost-sharing, but rather from general contributions to a clean environment and economic prosperity (e.g., sales of equipment and jobs creation). Part II of this report provides details on the audit findings and recommendations, and Part III includes detailed management and auditor comments

John C. Layton

John C. Layton
Inspector General

Attachment

cc: Deputy Secretary
Under Secretary

U.S. DEPARTMENT OF ENERGY

OFFICE OF INSPECTOR GENERAL

AUDIT OF DEPARTMENT OF ENERGY'S ACTIVITIES DESIGNED TO RECOVER THE TAXPAYERS' INVESTMENT IN THE CLEAN COAL TECHNOLOGY PROGRAM

Report Number: DOE/IG-0391
Date of Issue: June 6, 1996

Capital Regional Audit Office
Germantown, Maryland 20874

AUDIT OF DEPARTMENT OF ENERGY'S ACTIVITIES DESIGNED TO RECOVER THE TAXPAYERS' INVESTMENT IN THE CLEAN COAL TECHNOLOGY PROGRAM

TABLE OF CONTENTS

		Page
	SUMMARY	1
PART I -	APPROACH AND OVERVIEW	3
	Introduction	3
	Scope and Methodology	3
	Background	4
	Observations and Conclusions	5
PART II -	FINDINGS AND RECOMMENDATIONS	7
	1. Recovering the Taxpayers' Energy Investment	7
	2. Repayment Policies and Procedures	12
PART III -	MANAGEMENT AND AUDITOR COMMENTS	16
PART IV -	APPENDIX	18
	Management Comments on the Draft Report	18

U.S. DEPARTMENT OF ENERGY
OFFICE OF INSPECTOR GENERAL
OFFICE OF AUDIT SERVICES

AUDIT OF DEPARTMENT OF ENERGY'S ACTIVITIES DESIGNED TO RECOVER THE TAXPAYERS' INVESTMENT IN THE CLEAN COAL TECHNOLOGY PROGRAM

Audit Report Number: DOE/IG-0391

SUMMARY

The Congress in 1985 directed the Department of Energy to implement a Clean Coal Technology Program. The purpose of the program is to successfully demonstrate a new generation of advanced coal-based technologies and stimulate the movement of the most promising into the domestic and international marketplace. As part of this program, a goal was established to recover an amount up to the taxpayers' investment in successfully commercialized projects.

The clean coal program is the first major initiative by the Department without a legislative requirement to recover the taxpayers' investment in demonstrated technologies. As of December 31, 1995, the clean coal program included 42 projects with repayment agreements predicated on the successful commercialization of demonstrated technologies. The Department's cost share for these projects is approximately $2.3 billion while industry contributed about $3.7 billion. Our audit objectives were to determine whether clean coal recoupment practices are achieving the Department's goal of recovering the taxpayers' investment in successfully commercialized projects, and the impact of these practices on future Departmental recoupment efforts.

A detailed analysis of six projects revealed that recoupment decisions made by the Department limited its ability to recover the taxpayers' investment in clean coal projects. The decisions that were incorporated into repayment agreements exempted foreign sales, excluded some domestic sales on certain projects, and lowered the repayment rate on some sales. As a result of these decisions, the Department may not recoup an estimated $133.7 million of the taxpayers' $151 million investment in six projects and may limit its opportunity to recover future investments in other energy technology programs. A review of the financial controls over the repayment process also disclosed that the Department had not established formal policies and procedures to handle repayments due from sponsors.

To strengthen the recoupment process, we recommend that the Department formally analyze and justify any recoupment decision in future recoupment efforts that limits its ability to recover the taxpayers' investment in successfully commercialized technologies,

and establish and implement financial policies and procedures to ensure that sponsor repayments are timely, accurate, and complete. Management in responding to the report concurred with the recommendations.

Office of Inspector General

Office of Inspector General

PART I

APPROACH AND OVERVIEW

INTRODUCTION

In 1985, the Congress directed the Department of Energy to implement a Clean Coal Technology (CCT) Program. The purpose of the program is to successfully demonstrate a new generation of advanced coal-based technologies and stimulate the movement of the most promising into the domestic and international marketplace. As a part of this program, the Department, with the support of the Office of Management and Budget, established a goal to recover up to the taxpayers' investment in each successfully commercialized clean coal project.

The program is the Department's first major initiative at recoupment without a legislative requirement. As of December 31, 1995, the Department's program included 42 projects for which the Department's cost share was approximately $2.3 billion. In 1992, the Energy Policy Act required the Department to model repayment procedures for several of the Act's innovative technology transfer programs after those used in the clean coal program. Our objectives were to determine whether clean coal recoupment practices are achieving the Department's goal of recovering the taxpayers' investment in successfully commercialized projects and the impact of these practices on future Departmental recoupment efforts.

SCOPE AND METHODOLOGY

The audit included an examination of the clean coal recoupment practices for 16 of the 42 clean coal projects. The 16 projects, with an estimated cost of $735 million, had completed or nearly completed the technology demonstration phase. The Department's cost share for these projects totaled $314 million. A detailed analysis was conducted on six of these projects where recoupment decisions affected the ability of the Department to recover the taxpayers' investment. The estimated cost of these projects totaled $339 million, and the Department's cost share was $151 million. In addition to our review of the six projects, the audit included an examination of other energy program recoupment requirements and whether the Department analyzed the economic impact of its clean coal recoupment decisions. Audit work was conducted from May 1995 through January 1996 at Department Headquarters, the Pittsburgh and Morgantown Energy Technology Centers, and at selected CCT sponsor sites.

Discussions were held with Headquarters' clean coal officials and project managers at the Pittsburgh and Morgantown Energy Technology Centers to determine (1) the status and accomplishments of each CCT project, (2) what controls were established to account for and track project technology sales and repayments, and (3) what mechanism existed to ensure the accuracy and timeliness of repayments. These discussions were also used to obtain an understanding of the repayment agreements and to identify any changes in recoupment provisions. In addition, interviews were conducted with clean coal project sponsors to obtain their opinions regarding the commercial viability of demonstrated technologies. We also interviewed Ohio Coal Development Office officials to obtain their views, opinions, and philosophy relating to recoupment since they co-funded a number of the Department's clean coal projects and are attempting to recover their investment. Finally, the ability of the Department to meet the Energy Policy Act of 1992 recoupment requirements was evaluated using the Department's recoupment practices under the CCT Program.

Repayment provisions and subsequent changes to repayment provisions were analyzed to determine their effect on the ability of the Department to successfully implement its clean coal recoupment goal. Our analysis employed three methodologies. First, we determined what portion of the Department's investment was at risk through the exemption of foreign sales. Second, the impact of excluding some domestic sales was determined by calculating the value of exempted domestic sales and applying the appropriate repayment rate. Third, the impact of lowering the repayment rate was determined by applying alternative repayment rates to domestic sales.

The audit was performed in accordance with generally accepted Government auditing standards for performance audits, which included tests of internal controls and compliance with laws and regulations to the extent necessary to satisfy the objectives of the audit. We placed only limited reliance on computer-generated data during this audit, and thus, did not test the reliability of that data. Because our review of internal controls was limited, it would not necessarily have disclosed all internal control and compliance deficiencies that may have existed.

An exit conference was held on May 22, 1996, with the representatives of the Office of Coal Technology.

BACKGROUND

The CCT Program is a Government and industry cost-shared partnership implemented by the Department to demonstrate a new generation of advanced coal-based technologies and move promising technologies into the marketplace. The emphasis to commercialize these technologies reflects the strategic importance of coal to the U.S. economy and the commitment to sound environmental policies. Clean coal technology has helped ensure that coal will continue to serve U.S. energy interests, enhance opportunities for economic growth and employment, and aid in meeting national and international commitments for a clean and healthy environment. The CCT Program also plays a major role in ensuring that the U.S. leads the world in developing, applying, and exporting sustainable, clean, and economically competitive energy technologies.

The program began in 1985 and was expanded in 1987 to meet the recommendations of the United States and Canadian Special Envoys on Acid Rain. The industry contribution of about $3.7 billion was financed through sponsors as well as other corporate partners. Under the program, the Department may not finance more than 50 percent of the total costs of any single project and may only share in project cost growth up to 25 percent of the originally negotiated Government share.

The total cost of the 42 clean coal projects will approximate $6 billion. The Department's share for the current or completed projects is about $2.3 billion. These projects were selected through a series of rounds (Rounds I through V) of competitive solicitations over an 8-year period (1986-1993). As of December 31, 1995, 10 projects were completed, 9 had completed operational testing, 7 were in operation, 5 were under construction, and 11 were being designed. In addition to these 42 current or completed projects, 1 project was still in the pre-award phase at the time of our review.

The Government's funding commitments and Federal assistance terms are represented in cooperative agreements negotiated for each project. All of the 42 awarded projects contain repayment provisions agreed to by each of the project sponsors. These repayment agreements last 20 years and state that it is the intent of the Government to recoup up to the full amount of the taxpayers' contribution in each project once the technology has been commercialized. As of December 31, 1995, three sponsors repaid the Department $377,000 of the $33.4 million taxpayers' investment in their projects

In 1992, the Energy Policy Act required the Department to model repayment procedures for several of the Act's innovative technology transfer programs after those used in the clean coal program. These included Renewable Energy, Clean Coal, and Environmental Technology Transfer Programs. In addition, the Act specifically required the Department to re-examine its recoupment policies and establish procedures for its cost-share in other coal demonstration and commercial application projects.

OBSERVATIONS AND CONCLUSIONS

A detailed analysis of six clean coal projects indicated that the Department limited its ability to recover the taxpayers' financial investment through recoupment in successfully commercialized technologies. Decisions were made to (1) exempt foreign sales, (2) exclude some domestic sales, and (3) lower the repayment rate. These decisions were made without the benefit of any economic analysis to determine their impact on the Department's goal of recouping the taxpayers' investment. As a result, the Department may not recoup an estimated $133.7 million on six projects and may limit its opportunity to recover future investments in other energy technology projects. In this regard, the Energy Policy Act of 1992 directs the Department to model future recoupment procedures (for environmental, renewable energy, and innovative clean coal technology transfer programs) after the Department's clean coal program. Because of the potential impact of clean coal recoupment practices on these future programs, the Department should formally analyze and justify any recoupment decision that limits its ability to recover the taxpayers' investment in successfully commercialized technologies.

Prudent business practice also dictates that mechanisms be established to ensure that repayments due or made by clean coal and other future energy technology program sponsors are tracked, accounted for, and verified. Currently, the Department does not have a formal mechanism in place to achieve this objective. The audit found that the Department needs to establish formal financial policies and procedures over the repayment process. Also, the Pittsburgh and Morgantown Energy Technology Centers need to implement appropriate internal control mechanisms to ensure that sponsors' repayments are timely, accurate, and complete.

Part II of this report provides details on the findings and recommendations relating to the Department's activities designed to recover the taxpayers' investment in its clean coal technology program. Management concurred with the report's recommendations, but cautioned that the greatest payback to the nation will not be in the form of repayment of Federal cost-sharing. The payback will be from general contributions to a clean environment and economic prosperity (e.g., sales of equipment and jobs creation) Their comments are discussed in greater detail in Part III of the report and the Office of Coal Technology's comments are included verbatim in the Appendix to the report.

PART II

FINDINGS AND RECOMMENDATIONS

1. Recovering the Taxpayers' Energy Investment

FINDING

A goal of the Department is to recover up to the taxpayers' investment in successfully commercialized clean coal technologies. However, an analysis of six clean coal technology projects indicated that the Department limited its opportunity to recover the taxpayers' clean coal investment by (1) exempting foreign sales, (2) excluding some domestic sales on certain projects, and (3) lowering the repayment rate. The Department changed the recoupment provisions of its repayment agreements in an effort to respond to sponsors' complaints but did not analyze or justify the economic effect of each decision. As a result of these changes, the Department may not recoup an estimated $133.7 million of the taxpayers' $151 million investment in six clean coal technology projects and may limit its opportunity to recover future investments in other energy technology programs.

RECOMMENDATION

We recommend that the Deputy Assistant Secretary for Coal Technology, working with the Office of Environmental Management and the Office of Energy Efficiency and Renewable Energy, formally analyze and justify any recoupment decision in future recoupment efforts that limits the Department's ability to recover the taxpayers' investment in successfully commercialized technologies.

MANAGEMENT REACTION

Management concurred with the recommendation.

DETAILS OF FINDING

THE DEPARTMENT'S RECOUPMENT GOAL

The Department's policy is to recover "up to" the amount of the taxpayers' investment in each successfully commercialized clean coal project. This policy was included in all of the clean coal solicitations and in each repayment agreement. Most of the solicitations included language similar to the following:

> "It is the policy of the DOE to recover an amount up to (i.e., not to exceed) the Government's actual contribution to the Project. Repayment will derive from those Projects which are successful and achieve commercial application... The

Government's right to recover its contribution shall continue until either the Government has recouped its contribution or 20 years have elapsed from the effective date of the Repayment Agreement..."

CLEAN COAL RECOUPMENT PRACTICES

An analysis of six completed or nearly completed clean coal projects indicated that the Department limited its opportunity to recover the taxpayers' investment. Actions taken by the Department included:

- exempting foreign sales,
- excluding some domestic sales on certain projects, and
- lowering the repayment rate.

These actions were implemented as a part of the clean coal solicitation process. Under the Round I solicitation, repayment was derived from revenue generated from plant operations beyond the demonstration phase and/or the commercial sale, lease, manufacture, licensing, or use of the technology. In Round II, repayment was limited to the potential revenues from the future commercialization of the demonstrated technology. For Round III, repayment was limited to U.S. sales only, while the repayment rate was adjusted from 2 to 0.5 percent of equipment sales. In addition, other sales were exempted from recoupment at the discretion of the Department's negotiating team. The recoupment provisions for Round IV and V were identical to those in Round III.

Provided below is a description of the changes that were made to clean coal repayment agreements.

Foreign Sales Exempted

The Department limited its opportunity to recover an estimated $120.3 million in four clean coal projects through the exemption of foreign sales. A clean coal official believed that the rising price of fuels competing with coal, the expectations of more stringent air pollution controls, and forecasts of the increasing need for new electric generation capacity would push demonstrated clean coal technologies into the domestic marketplace. However, a 1994 National Coal Council report, sponsored by the Department, concluded that an expansion of the foreign market was favorable. This was supported by a project sponsor that forecast domestic and foreign sales for its technology. The sponsor's forecast for foreign sales was approximately 1 1/2 times larger than its forecast for domestic sales. Another reason why Departmental officials excluded foreign sales from the recoupment process was that they believed that a mechanism could not be established to verify sales outside of the United States. However, further discussions with officials indicated that the Department had not established a mechanism to verify either foreign or domestic sales. The absence of a verification process is discussed further in Finding 2 of this report.

Some Domestic Sales Excluded

The Department also exempted some domestic sales from its repayment agreements. As a consequence, an opportunity was missed to recover an estimated $12.7 million on two projects. The exclusions exempted $2.5 billion in sales on one project that could have resulted in a repayment of $12.5 million, and $200 million in sales made on the other project during the demonstration period that could have resulted in repayment of $200,000.

A clean coal official on the first project stated that sales were not included as a part of the repayment agreement because the Department was not initially involved in the project, and its technology was developed without any Department funding. However, the Department invested over $17 million to demonstrate this technology, and this demonstration was instrumental in the successful testing and commercialization of the technology.

On the second project, the Department contributed $63.9 million but did not include a repayment provision for sales made during the demonstration period. A clean coal official stated that these sales were excluded from the repayment agreement because the Department did not believe that sales of the technology would occur prior to completion of the demonstration phase. However, the project demonstration phase lasted 3 years, and some successful test results were available prior to the end of the demonstration period. As a result, the market recognized the benefits associated with the technology, and an order for the technology was placed.

Repayment Rate Lowered

The Department also decreased the repayment rate on sales of demonstrated technologies. The repayment rate for sales decreased from 2 percent of gross revenues in Round II to 0.5 percent of gross revenues for Rounds III through V. As a result of these actions, the Department lost an opportunity to recoup an estimated $700,000 on one project.

The Ohio Coal Development Office (OCDO), a state agency, and the Electric Power Research Institute (EPRI), a utility association, participated in the aforementioned project with the Department. Each party negotiated repayment agreements with the sponsor based on the successful commercialization of the technology. Based on forecasted sales of the technology, the Department can expect to recover 4.7 percent of the taxpayers' original investment, while OCDO and EPRI can expect to recoup 41.3 percent and 9.5 percent of their respective investments. According to a clean coal official, the Department's repayment rate was decreased (from 2 to 0.5 percent of gross revenues) to bring it more in line with current business practices. Headquarters' officials could not provide documentation supporting the 0.5 percent rate as being the current business rate used on projects of this type. An industry clean coal project official indicated that the repayment rate of 0.5 percent was too low and stated that it should have been between 1 and 5 percent depending on the technology's commercial potential.

COMMERCIAL VIABILITY VERSUS RECOUPMENT

Changes to recoupment provisions were made through the solicitation process and were made in part to address the concerns of clean coal project sponsors. However, an economic analysis was not performed to determine the effect of the changes on the Department's goal to recover the taxpayers' investment in clean coal technologies. The concerns of Department officials were ensuring that the clean coal technologies were commercialized, improving the timeliness of formalizing the cooperative agreements, and responding to other industry concerns about the recoupment provisions to ensure the industry's participation in the clean coal program.

Management officials believed that their recoupment decisions would assist in making the technologies more competitive, lessen delays in the cooperative agreement negotiation process, and maintain industry's interest in the program. However, the General Accounting Office, in a 1991 report, "Improvements Needed in DOE's Clean Coal Technology Program," recommended that the Department analyze the effect that recoupment provisions have had on industry participation in the clean coal program and the likelihood of recovering the Federal investment. As of January 31, 1996, the Department had not taken any action to satisfy the General Accounting Office's concern.

IMPACT ON THE RECOVERY OF THE TAXPAYERS' INVESTMENT

Departmental actions, made without the benefit of an economic analysis, limited the Department's ability to recoup the taxpayers' investment in successfully commercialized clean coal projects. Although the potential may exist that the Department could recover the taxpayers' investment from domestic sales, project managers and project sponsors indicated that the domestic market for clean coal technologies is currently very limited, and unless market conditions change, recoupment from future domestic sales will be negligible. As illustrated in Table 1, the Department limited its opportunity to recover an estimated $133.7 million of the taxpayers' $151 million investment in six clean coal technology projects.

Table 1

Potential Dollar Impact of DOE Recoupment Decisions

Decision	Potential Dollar Impact (in millions)
Exempted Foreign Sales	$120.3
Excluded Some Domestic Sales	12.7
Lowered Repayment Rates	.7
Total	$133.7

In addition to the six projects examined as a part of this audit, the decision to exempt foreign sales from recoupment has much broader impact when looking at the entire clean coal program. For instance, the foreign sales exemption extends to an additional 19 clean coal projects that will be completed in the future. The Department invested over $1.4 billion in these 19 projects. The exemption will greatly hinder the Department's goal of recovering the taxpayers' investment in these projects when one considers that 75 percent of the expected worldwide growth in coal use is expected to occur outside the United States. For example, the Department in 1993 reported that the potential clean coal technology market for new facilities and retrofit installations outside the United States for the 1993-2010 period was between $571 billion and $870 billion. Repayments from successful commercialization of the 19 projects outside the U.S. could potentially have resulted in the recovery of the taxpayers' investment in these technologies.

In addition, the Energy Policy Act of 1992 requires the recoupment of the taxpayers' investment in other cost shared demonstration and commercial application projects. This Act stipulates that these other projects should model their recoupment procedures, to the extent appropriate, after the Clean Coal Technology Program. Under the Act, $1.8 billion has been authorized for three technology transfer programs: Environmental, Renewable Energy, and Clean Coal. As of February 1996, funding for these programs had not been appropriated. However, if funding is provided, potential repayments could be significant, and the Department needs to take steps to ensure that any actions that reduce the opportunity to recoup the taxpayers' investment in these programs are justified.

2. Repayment Policies and Procedures

FINDING

Prudent business practice dictates that controls be established to ensure that moneys for which the Government is entitled to are tracked, accounted for, and verified. However, the Morgantown and Pittsburgh Energy Technology Centers had not instituted any mechanism to monitor clean coal project repayments, and the Department had not established any formal recoupment policies and procedures. The Centers were waiting until projects were completed and repayments were made by project sponsors to establish such mechanisms, and the Department did not anticipate a need for such policies and procedures. Without appropriate policies and procedures, the Department's ability to collect moneys due the Federal Government from successfully commercialized clean coal projects may be impaired.

RECOMMENDATIONS

We recommend that the Office of Chief Financial Officer establish financial policies and procedures over Departmental recoupment activities. We also recommend that the Managers of the Energy Technology Centers implement, as quickly as possible, mechanisms to ensure that sponsor repayments are timely, accurate, and complete.

MANAGEMENT REACTION

Management concurred with the finding and recommendations.

DETAILS OF FINDING

ENSURING TIMELY, ACCURATE, AND COMPLETE REPAYMENTS

The clean coal program's recoupment goal is to recover up to the amount of the taxpayers' investment in each clean coal project. In this regard, prudent business practice dictates that the Department have financial policies and procedures in place to ensure that repayments made by clean coal technology sponsors are tracked, accounted for, and verified.

Specific guidance on the internal controls to be established are found in Departmental directives. Department Order 1000.3C states that internal controls should comprise the plans of the organization, methods, and procedures adopted by management to provide reasonable assurance that program objectives are achieved effectively and efficiently and that revenues applicable to the Department's operations are properly recorded and accounted for. The Department's Accounting Handbook further states that procedures to account for cash from its receipt to final disposition must include safeguards necessary to ensure proper control including the receiving, safeguarding, recording, and depositing of cash on a timely basis and for keeping the required records and accounts.

MECHANISMS TO MONITOR CLEAN COAL REPAYMENTS

At the time of our review, the Department had not established a financial policy for recoupment, and the Morgantown and Pittsburgh Energy Technology Centers had not established mechanisms to track, account for, and verify clean coal repayments. A policy and an implementing mechanism are needed to ensure that sales activity and repayment reporting are monitored, repayments are accounted for, and the accuracy and completeness of sales reports and repayments are verified. A review of Departmental accounting policy manuals and orders indicated that a financial policy for the recoupment of the taxpayers' investment in clean coal projects did not exist. A discussion with a Headquarters' official confirmed that a Departmental recoupment policy had not been established.

Tracking Sales Activity and Repayment Reporting

A requirement for sponsor sales activity and repayment reporting was included in all repayment agreements after the Round 1 solicitation. The project sponsor is required to submit an annual sales activity and repayment report subsequent to the completion of project operations. These reports are to detail any sales of project technology for which the Department would be entitled to repayment.

The Energy Technology Centers, however, had not established a mechanism to track when sales activity and repayment reports were due. Both Centers relied on project sponsors for timely submission of these reports. A review of six projects' records indicated that one annual sales activity and repayment report had never been submitted to the Department. The review also revealed that three reports due on two projects had been submitted any where from 2 to 11 months late. According to the responsible clean coal officials, they did not realize that the reports either were late or had not been received.

Accounting for Repayments

The Department should also implement appropriate accounting procedures over the collection and disposition of repayments. According to the administrative provisions of Public Law 103-138. (Department of Interior and Related Agencies Apropriations Act, 1994), revenues and other moneys received by or for the account of the Department (or otherwise generated by the sale of products in connection with projects of the Department appropriated under this Act) may be retained by the Secretary of Energy. These revenues are available until expended and should be used only for plant construction, operation costs, and payments to cost sharing entities as provided in appropriate cost sharing contracts or agreements. The Office of Inspector General found that the Energy Technology Centers used similar methods when accounting for their repayments. Both Centers correctly transmitted and credited repayments to the Department of Treasury's clean coal appropriation account where the repayments offset the clean coal appropriation. In responding to the draft report, the Office of Chief Financial Officer indicated that additional financial guidance pertinent to the recoupment process was warranted, and that they will develop appropriate financial policies and procedures over Department recoupment efforts for inclusion in the Departmental Accounting Handbook.

Verifying Accuracy and Timeliness of Repayments

The Energy Technology Centers also had not established a control mechanism to verify the accuracy and timeliness of sponsor repayments. Six repayments were received as of December 1995. However, one payment was late by 2 months. The clean coal official responsible for receiving the repayment stated that he was not aware when the sponsor should have started repaying the Department's investment. The Department needs to develop a mechanism to ensure this and other repayments are timely, accurate, and complete. The Energy Technology Centers should also establish procedures to verify the accuracy of the repayments reported by the sponsors.

REPAYMENT MECHANISM NOT ESTABLISHED

Controls over repayments were discussed with a Headquarters' official. He stated that Departmental financial policy and procedures were not established because recoupment applied only to a single Departmental program, the Clean Coal Technology Program. He also explained that the Department generally does not establish a Departmentwide financial policy for a requirement that is applicable to a single program and left implementation up to the Energy Technology Centers. The Headquarters' official, however, acknowledged that the Energy Policy Act of 1992 requirement to include recoupment in several Departmental programs should have prompted the development of Departmentwide financial policies and procedures.

Officials at the Energy Technology Centers explained that when clean coal program officials selected the first projects in 1986, they realized that it would be several years before any of the projects reached the commercialization stage and recoupment became a reality. These program officials decided to wait until projects were completed and repayments began before implementing a mechanism to track, account for, and verify repayments.

In the fall of 1995, the Energy Technology Centers established a joint process improvement team to develop procedures for handling, tracking, accounting for, and verifying repayments received from clean coal technology projects. According to Morgantown and Pittsburgh officials, the process improvement team was established to respond to this audit's inquiries. These inquiries centered on what mechanisms the Energy Technology Centers had established to track, account for, and verify potential moneys owed by clean coal technology sponsors.

The process improvement team's first meeting was in November 1995, and their final report was issued in April 1996. The report recommends that (1) data from annual sales activity and repayment reports be recorded in the Reports Receipts Tracking database, (2) repayments be processed as an appropriation reimbursement to the Clean Coal Technology Program, and (3) personnel responsible for oversight and auditing ensure that these processes occur.

ASSURANCE THAT REPAYMENTS ARE TIMELY AND ACCURATE

Without appropriate policies and procedures to properly track, account for, and verify repayments, the Department's ability to collect moneys due the Federal Government from successfully commercialized clean coal projects may be impaired. The need for these policies and procedures is also underscored by the recoupment requirements of other future Departmental programs. The Energy Policy Act has authorized $1.8 billion for Innovative Coal, Environmental, and the Renewable Energy Technology Transfer Programs. These programs also require the repayment of the taxpayers' investment in successfully commercialized technologies. The lack of policies and procedures reduces the assurance that the Department will recover the taxpayers' investment in successfully commercialized projects.

In addition, the Energy Technology Centers need to ensure implementation of the recommendations of their process improvement team. Implementation should assist the Energy Technology Centers on accurately recouping the taxpayers' investment in the Clean Coal Technology Program. As of December 1995, with over $377,000 in repayments already received and significant sums potentially due the Department, it is crucial that a system be in place to ensure accurate and complete accounting for all repayments.

PART III

MANAGEMENT AND AUDITOR COMMENTS

The Deputy Assistant Secretary for Coal Technology, the Deputy Controller, and the Directors, Pittsburgh and Morgantown Energy Technology Centers, concurred with the report's three recommendations. However, the Deputy Assistant Secretary cautioned that the greatest payback to the nation from the program will not be in the form of repayment of Federal cost-sharing, but rather from general contributions to a clean environment and economic prosperity (e.g., sales of equipment and jobs creation). His comments in their entirety are included in the Appendix. Management comments and related auditor comments by recommendation follow.

Recommendation 1. Formally analyze and justify any recoupment decision in future recoupment efforts that limits the Department's ability to recover the taxpayers' investment in successfully commercialized technologies.

Management Comments. Management concurred with Recommendation 1. They agreed that the recommendation was worthy of support and implementation. Management added that the recommendation will be accommodated by applying a formal process to record the analysis and justification process used in recoupment decisions.

Auditor Comments. Management's intended effort to document and record the analysis and justification of their recoupment decisions is considered responsive to our recommendation.

Recommendation 2. Establish formal financial policies and procedures over Departmental recoupment activities.

Management Comments. Management concurred with this recommendation and stated that they planned to establish financial policies and procedures by January 31, 1997.

Auditor Comments. Management plans to develop financial policies and procedures over Departmental recoupment activities for inclusion in the DOE Accounting Handbook is considered responsive to our recommendation.

Recommendation 3. Implement as quickly as possible mechanisms to ensure that sponsor repayments are timely, accurate, and complete.

Management Comments. Management concurred with this recommendation and supports both Energy Technology Centers' effort to effectively carry out their responsibilities pertaining to repayment.

Auditor Comments. Management's intention to support both Energy Technology Centers' effort to track, account for, and verify repayments is considered responsive to our recommendation.

APPENDIX

Department of Energy
Washington, DC 20586

MAY [illegible]

MEMORANDUM

To: Philip L. Holbrook, Manager
Capital Regional Audit Office
Office of Inspector General

From: George Rudins, DAS for Coal Technology, FE-20

Subject: Review of Draft Report " Department of Energy's Activities Designed to Recover its Investment in the Clean Coal Technology Program"

INTRODUCTION:

The projects in the Clean Coal Technology Program have been selected over five competitive solicitations. Each solicitation proceeded under a different set of criteria or objectives. In each case Congress played a key but variable role in setting expectations for the program. Guidelines were evolved as Congress, the Department of Energy, and the industrial participants entered into a continuing series of precedent setting procedures. Repayment provisions also changed over time due to difficulties in negotiation and changes in congressional direction on repayment.

The focus on repayment, taken out of context and without a simultaneous consideration of its evolution, management and implementation to achieve its designed purpose consistent with achievement of programmatic goals will result in a limited, not fair, assessment of its role in this technology development program. One must consider issues such as degree of cost sharing, commitment and capability of participants, technology viability, potential markets, societal benefits, and other pay backs to the taxpayer. It must also be recognized that the greatest payback to the nation from the Program will not be in the form of repayment of Federal cost sharing. It will be in the form of assuring U.S. technology leadership, accompanying global sales and jobs, and general contribution to a clean environment and economic prosperity.

DISCUSSION:

Most of the recommendations already have been implemented to some degree. Every decision on recoupment has been made within the context of the primary objective of the program (i.e., the expeditious and successful development of technology) and in full recognition of the associated need to recover the taxpayers' investment from successfully commercialized technologies.

Of considerable concern however, is the principal premise of the report and the impressions it leaves. The evaluation proceeds on the premise that the sole measure of program success is the ability of the government to recoup up to the full amount of the taxpayers' contribution in each project once the technology has been commercialized. The objective of the program is to repay the taxpayer many times over the investment made, but not just through these specific repayments.

- The Clean Coal Technology Program is focussed on the demonstration of a portfolio of technologies. If successful, the nation will benefit through cleaner air, lower cost electricity, lower environmental compliance cost and global sales (with accompanying jobs, improvement in the trade balance, and incresased tax revenue).

- Recoupment as a concept was implemented to eliminate the possibility of "undue enrichment by the participant as a result of government support of its technology development efforts." It was implemented to acquire an equitable share of the profits, should they occur, not as an investment strategy.

- Recoupment can be a disincentive to achieving the program objectives. Management of recoupment through negotiation has been essential with every project to achieve industrial participation and to accomplish the departments' goals in the development of clean coal technology.

- Recoupment policy must be flexible in its application or it will limit achievement of the associated program goals, with their greater payback to the nation.

- Projects demonstrating foreign technology may have to accommodate previously established market designations which limit foreign sales for consideration as sources of recoupment.

This same emphasis on recoupment as a principal criteria of performance in the implementation of the clean coal program requires comment:

- Recoupment policy: Through most of the report an existence of a Department policy on recoupment is recognized as a guiding principle to positions taken. However, at one point the report also notes that a review of departmental accounting policy manuals and orders indicate that a policy for recoupment of the Department's investment in Clean Coal projects did not exist. As a matter of practice "the policy of repayment was an implementing tool of the program (included in every PON) and accordingly used."

- Repayment/Recoupment is a concept that must be specifically negotiated based on the requirements, criteria, provisions etc., of a specific technology effort. It should not be raised in importance to a level that it limits the degree to which program objectives are achieved. Compromises in the terms of repayment to achieve program objectives should be acceptable and not imply unmerited accommodation.

- The objectives, contributions, and desired results of each of the participants in a project (government/private) are very different and established through separate negotiations. The comparative degree of repayment achieved by each such participant cannot be used as a measure of performance unless evaluated within the context of the terms of the respective agreements.

- o The success of repayment as a concept in the Clean Coal Program cannot be established until it can be determined how many projects were successfully completed, how many were successfully commercialized and what total amount of profits were earned.

CONCLUSIONS/RECOMMENDATIONS:

The two recommendations made as a result of the review are valid comments on the Clean Coal Program, and we believe that they have been or are already being implemented. Recommendation 1 will be fully accommodated by applying a more formal process to record the analysis and justification process used in recoupment decisions. Recommendation 2 will be implemented by continuing to a logical conclusion the work started by the "Joint Process Improvement Team" established by the Energy Technology Centers.

Followup Questions and Answers

Mr. W. Henson Moore
Former Deputy Secretary of Energy and President and CEO
American Forest and Paper Association

Followup Questions and Answers

Hearing on "*Funding Department of Energy Research and Development in a Constrained Budget Environment*:" Follow-up questions to W. Henson Moore:

Question 1: The GAO found some employees at DOE who said the administrative and auditing costs of a repayment program might make it self-defeating. Did you look at this problem in 1991 and what did you conclude?

Answer:

Yes, I was told by the staff at DOE that a repayment program could be administratively onerous. But this was opinion rather than fact. I saw no analysis indicating that the management of a program seeking repayment for Federal investment in R&D would be any more complex, or presented any greater difficulties, than the management of any other aspect of technology research and development.

The GAO continues to report that DOE staff *opinions* remain unchanged from those expressed during my incumbency. I find this unfortunate, for in my view there would be no more compelling case to be made to the American people, for a strong Federal role in R&D, than the presentation of evidence that taxpayers can expect a return on the investment they make in the development of technology that is also highly valued by the economy at large.

Question 2: Agencies by nature hate to give up any flexibility. How would you respond to the argument that eliminating waivers sets up a regulatory straightjacket?

Answer:

I am persuaded, on the basis of the evidence presented in reports by the GAO and by DOE's Inspector General, that the granting of waivers for co-financing or recoupment of investment in Federal R&D is driven largely by political rather than by economic or technical considerations. The issue does not usually arise if Federal requirements for co-financing and licensing fees are spelled out at the outset as a condition of the joint Federal-private venture. In the case of the Clean Coal Technology program, for example, the government had no difficulty whatsoever in securing - in some cases exceeding - co-financing commitments from its private sector partners. Nor were there problems encountered in the case of the Advanced Battery Consortium. Rather, problems have arisen, in the main, only when Federal managers of R&D were directed to seek co-financing and recoupment for projects they historically managed without such requirements.

In sum, waiver authority has in my view been abused to the detriment of the taxpayers and for purposes other than those justifiable on demonstrably technical or economic grounds. This abuse argues therefore for either tightening the criteria currently in the law, or eliminating the authority altogether except for cases in which it can be demonstrated - analytically not anecdotally - that flexibility would enhance the government's stake.

It should be noted, in any case, that the management of R&D is not a *regulatory* practice at all, and cannot consequently be straightjacketed as would the issuance of a rule. The analogy is otherwise outdated in the sense that successful regulation is more likely to emerge from negotiations than from directives. Similarly, the conditions of participation in Federal R&D should be negotiated with private partners, but on the basis of prevailing industry practices. The government should not be an easy mark for the development and dissemination of valuable technology, and the taxpayers' initial and residual stake should not be reduced or discarded for the sake of usually temporary political expediency. Moreover, it is seldom if ever the case that legitimate firms expect to pay little or nothing for something of value.

Question 3: You've had a chance to review the program you proposed five years ago. In light of DOE structural changes and the Galvin report recommendations, would you go at it any differently?

Answer:

The vision is always clearer in retrospect. I acted as I did on the basis of the knowledge and authority available at the time. Since the time of my tenure at DOE, Congress has given statutory force to the idea that Federal R&D is not an entitlement for the industries affected by it; that it has a market value; and that the Federal establishment is more likely to make better policy choices if a private sector partner is involved.

With the experience now available as to implementation of Section 3002 (cost-sharing), and Section 1301 (repayment) of the Energy Policy Act of 1992, it seems reasonable to conclude that the intent of Congress has only partially been fulfilled. This intent is not likely to be fully honored, apparently, unless the discretion of the Secretary of Energy is reduced sufficiently to ensure a reasonable government return on investment. In that vein, I would view the repayment on Federal investment so far registered for the Clean Coal Technology program - a miserly $377,000 - to be *not* reasonable for an outlay of $2.5 billion.

I would in retrospect insist on greater internal DOE analytical capabilities - in the typically objective policy office rather than with the vested programmatic assistant secretaries - to assess the true economic and market value of R&D investments, and to monitor and internalize best industry practices in technology transfer and licensing. I would insist that co-financing and recoupment agreements with both public and private sector participants - at home and abroad - be negotiated with a view to securing for the taxpayers the *maximum - rather than the current token - feasible return* on investment. And I would place my seal of approval only on those R&D project partnerships that would have pre-conditionally received public scrutiny and comment as a result of publication of details of agreements in the Federal Register.

Mr. Roger A. Lewis
Senior Advisor
Office of Strategic Computing and Simulation
U.S. Department of Energy

Followup Questions and Answers

HEARING OF THE SUBCOMMITTEE ON ENERGY AND ENVIRONMENT
COMMITTEE ON SCIENCE
U.S. HOUSE OF REPRESENTATIVES

on

Funding Department of Energy Research and Development in a Constrained Budget Environment

Thursday, August 1, 1996

Followup Questions Submitted to

Mr. Roger Lewis
Senior Advisor
Office of Strategic Computing and Simulation
U.S. Department of Energy

Q1. What is the current basis for deciding how a program will be structured as to repayment? Is it randomly decided through negotiation or does a set policy exist?

A1. Currently the program management makes a determination as to whether a repayment provision is to be sought. There is no policy to require recoupment or repayment. In specific areas, such as steel and aluminum research and the Clean Coal Technology Program, repayment policy has been specified by statute.

Q2. A few weeks ago, five laboratories announced an agreement with SY-BUS of Sunnyvale, California to commercialize an innovative waste-cleanup technology. The agreement involves a seventeen-year exclusive patent for the company and a 5% royalty payment to the labs. What role did DOE play? Will the royalty monies actually go back into programs?

A2. DOE played no role in the negotiations leading to the agreement between the five laboratories and SY-BUS. Each of the five laboratories contributed either background patents or software to create a package of technology that was licensed to SY-BUS under both a patent license and a software license. The royalties will be shared by the five laboratories. The royalties have to remain at the laboratories and can be used for various specific activities enumerated in each of the laboratory's prime contracts with DOE. More specifically, royalties can be used for payments to inventors, for scientific research, development, technology transfer and education at the laboratories, and for payment of expenses incidental to the administration and licensing of intellectual property. If the net amounts of such royalties received from licensing after payment of patenting costs, licensing costs, payments to inventors and other expenses incidental to the administration of inventions during any fiscal year exceeds 5% of the laboratory's budget for that fiscal year, 75% of such excess amounts must be paid to the Treasury.

Q3. Could you describe for us the money stream in current DOE repayment agreements. Are there legal barriers to putting monies received directly back into programs?

Note: DOE did not answer.

Q4. You stated on page 3 of your prepared testimony that "provisions for grants and cooperative agreements follow the guidance provided in the DOE Financial Assistance Regulations at 10 CFR 600. Specific requirements for cost sharing are found at 10 CFR 600.123."

Please provide a copy of the text of 10 CFR 600.123.

A4. Attached is a copy of the text of 10 CFR 600.123.

10 CFR 600.123 Cost sharing or matching.

(a) All cost sharing or matching contributions, including cash and third party in-kind, shall meet all of the following criteria.

(1) Are verifiable from the recipient's records.

(2) Are not included as contributions for any other federally-assisted project or program

(3) Are necessary and reasonable for proper and efficient accomplishment of project or program objectives

(4) Are allowable under the applicable cost principles.

(5) Are not paid by the Federal Government under another award, except where authorized by Federal statute to be used for cost sharing or matching.

(6) Are provided for in the approved budget.

(7) Conform to other provisions of this subpart, as applicable.

(b) Unrecovered indirect costs may be included as part of cost sharing or matching.

(c) Values for recipient contributions of services and property shall be established in accordance with the applicable cost principles. If DOE authorizes recipients to donate buildings or land for construction/facilities acquisition projects or long-term use, the value of the donated property for cost sharing or matching shall be the lesser of either paragraph (c)(1) or (2) of this section.

(1) The certified value of the remaining life of the property recorded in the recipient's accounting records at the time of donation.

(2) The current fair market value. However, when there is sufficient justification, DOE may approve the use of the current fair market value of the donated property, even if it exceeds the certified value at the time of donation to the project.

(d) Volunteer services furnished by professional and technical personnel, consultants, and other skilled and unskilled labor may be counted as cost sharing or matching if the service is an integral and necessary part of an approved project or program. Rates for volunteer services shall be consistent with those paid for similar work in the recipient's organization. In those instances in which the required skills are not found in the recipient organization, rates shall be consistent with those paid for similar work in the labor market in which the recipient competes for the kind of services involved. In either case, paid fringe benefits that are reasonable, allowable, and allocable may be included in the valuation.

(e) When an employer other than the recipient furnishes the services of an employee, these services shall be valued at the employee's regular rate of pay (plus an amount of fringe benefits that are reasonable, allowable, and allocable, but exclusive of overhead costs), provided these services are in the same skill for which the employee is normally paid.

(f) Donated supplies may include such items as office supplies, laboratory supplies or workshop and classroom supplies. Value assessed to donated supplies included in the cost sharing or matching share shall be reasonable and shall not exceed the fair market value of the property at the time of the donation.

(g) The method used for determining cost sharing or matching for donated equipment, buildings and land for which title passes to the recipient may differ according to the purpose of the award, if either paragraph (g)(1) or (2) of this section apply.

(1) If the purpose of the award is to assist the recipient in the acquisition of equipment, buildings or land, the total value of the donated property may be claimed as cost sharing or matching.

(2) If the purpose of the award is to support activities that require the use of equipment, buildings or land, normally only depreciation or use charges for equipment and buildings may be made. However, the full value of equipment or other capital assets and fair rental charges for land may be allowed, provided that DOE has approved the charges.

(h) The value of donated property shall be determined in accordance with the usual accounting policies of the recipient, with the following qualifications.

(1) The value of donated land and buildings shall not exceed its fair market value at the time of donation to the recipient as established by an independent appraiser (e.g., certified real property appraiser or General Services Administration representative) and certified by a responsible official of the recipient.

(2) The value of donated equipment shall not exceed the fair market value of equipment of the same age and condition at the time of donation.

(3) The value of donated space shall not exceed the fair rental value of comparable space as established by an independent appraisal of comparable space and facilities in a privately-owned building in the same locality.

(4) The value of loaned equipment shall not exceed its fair rental value.

(i) The following requirements pertain to the recipient's supporting records for in-kind contributions from third parties.

(1) Volunteer services shall be documented and, to the extent feasible, supported by the same methods used by the recipient for its own employees.

(2) The basis for determining the valuation for personal service, material, equipment, buildings and land shall be documented.

(j) DOE shall specify in the solicitation or in the program rule, if any, any cost sharing requirement. The award document shall be specific as to whether the cost sharing is based on a minimum amount for the recipient or on a percentage of total costs.

(k) If DOE requires that a recipient provide cost sharing which is not required by statute or which exceeds a statutory minimum, DOE shall state in the program rule or solicitation the reasons for requiring such cost sharing, recommended or required levels of cost sharing, and the circumstances under which the requirement for cost sharing may be waived or adjusted during any negotiation.

(l) Whenever DOE negotiates the amount of cost sharing, DOE may take into account such factors as the use of program income (see □600.124), patent rights, and rights in data. Foregone fee or profit shall not be considered in establishing the extent of cost sharing.

Q5. You also stated on page 3 of your prepared testimony that "[t]he DEAR contains instructions on cost "participation" at Subpart 917.70. (48 CFR 917.70). The DEAR is couched in terms of policy rather than contract clauses. It states at 917.7001(d) that cost participation is required for demonstration projects unless exempted by the Under Secretary. DOE has no general regulations specifying terms and conditions for transactions that might provide for recoupment."

Please provide a copy of the relevant text of the DEAR.

A5 Following is the text of DEAR 917.7001(d).

ACQUISITION REGULATIONS AMENDMENT 20

(d) Cost participation is required for demonstration projects unless exempted by the Under Secretary. Demonstration projects, pursuant to this subpart, include demonstrations by technological advances and field demonstrations of new methods and procedures, and demonstrations of prototype commercial applications for the exploration, development, production, transportation, conversion, and utilization of energy resources.

917-3

Q5A. You also stated on page 3 of your prepared testimony that "[t]he Department does have a Model CRADA, as required by law. . ."

Please provide a copy of this "Model CRADA."

A5A. Attached is a copy of the DOE Model CRADA.

Introduction

This document, to be referred to as the DOE sample CRADA, has been developed to be responsive to the needs of different CRADA Participants while protecting the interests of the Government and the U.S. taxpayers and is a tool for DOE and its Government-Owned Contractor-Operated (GOCO) laboratories, hereafter referred to as laboratories, to facilitate the negotiation, development and timely approval of CRADAs.

This sample CRADA incorporates three types of provisions:

(1) Those few that are required by statute or policy, [set off by double underscore] are strongly recommended for timely approval, and can only be changed with DOE Headquarters approval. Changing double underscored language or examples will delay the process, perhaps substantially.

(2) Those that sound judgment suggests have a valid basis for being included in the terms and conditions of the CRADA.

(3) Those that are left solely to the negotiations between the laboratory and the Participants. [Shown in brackets.]

STEVENSON-WYDLER (15 USC 3710)
COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENT (hereinafter "CRADA") No. _____

BETWEEN

____

under its U.S. Department of Energy Contract

No. __________ (hereinafter "Contractor")

AND

____________________ (hereinafter "Participant"),

both being hereinafter jointly referred to as the "Parties"

ARTICLE I: DEFINITIONS

A. "Government" means the United States of America and agencies thereof.

B. "DOE" means the Department of Energy, an agency of the United States of America.

C. "Contracting Officer" means the DOE employee administering the Contractor's DOE contract.

D. "Generated Information" means information produced in the performance of this CRADA.

E. "Proprietary Information" means information which embodies (i) trade secrets or (ii) commercial or financial information which is privileged or confidential under the Freedom of Information Act (5 USC 552 (b)(4)), either of which is developed at private expense outside of this CRADA and which is marked as Proprietary Information.

F. "Protected CRADA Information" means Generated Information which is marked as being Protected CRADA Information by a Party to this CRADA and which would have been Proprietary Information had it been obtained from a non-federal entity.

G. Subject Invention means any invention of the Contractor or Participant conceived or first actually reduced to practice in the performance of work under this CRADA.

H. "Intellectual Property" means patents, trademarks, copyrights, mask works, protected CRADA information and other forms of comparable property rights protected by Federal Law and other foreign counterparts.

I. "Trademark" means a distinctive mark, symbol or emblem used in commerce by a producer or manufacturer to identify and distinguish its goods or services from those of others.

J. *"Service Mark" means a distinctive word, slogan, design, picture, symbol or any combination thereof, used in commerce by a person to identify and distinguish its services from those of others.*

K. "Mask Work" means a series of related images, however fixed or encoded, having or representing the predetermined, three-dimensional pattern of metallic, insulating or semiconductor material present or removed from the layers of a semiconductor chip product; and in which series the relation of the images to one another is that each image has the pattern of the surface of one form of the semiconductor chip product.

L. "RD&D" means research, development and demonstration performed by the Contractor and the Participant under this CRADA, including works performed by consultants or other contractors and subcontractors under this CRADA.

M. "Background Intellectual Property" means the Intellectual Property rights in the items identified by the Parties in Appendix D, Background Intellectual Property, which were in existence prior to or are first produced outside of this CRADA, except that in the case of inventions in those identified items, the inventions must have been conceived outside of this CRADA and not first actually reduced to practice under this CRADA to qualify as Background Intellectual Property. Licensing of Background Intellectual Property, if agreed to by the Parties, shall be the subject of separate licensing agreements between the Parties. Background Intellectual Properties are not Subject Inventions.

ARTICLE II: STATEMENT OF WORK

Appendix A, Statement of Work, is hereby incorporated into this CRADA by reference.

OR

Appendix A is the Statement of Work.

ARTICLE III: TERM, FUNDING AND COSTS

A. The effective date of this CRADA shall be the latter date of (1) the date on which it is signed by the last of the Parties hereto or (2) the date on which it is approved by DOE. The work to be performed under this CRADA shall be completed within _____ months/years from the effective date.

B. The Participant's estimated contribution is $_____. The Government's estimated contribution, which is provided through the Contractor's contract with DOE, is $_____, subject to available funding.

C. Neither Party shall have an obligation to continue or complete performance of its work at a contribution in excess of its estimated contribution as contained in Article III A above, including any subsequent amendment.

D. Each Party agrees to provide at least ___days' notice to the other Party if the actual cost to complete performance will exceed its estimated cost.

E. [For CRADAs which include (non-Federal) funding on a funds-in basis, an advance payment provision will be negotiated consistent with current DOE policy.]

ARTICLE IV: PERSONAL PROPERTY

All tangible personal property produced or acquired under this CRADA shall become the property of the Participant or the Government depending upon whose funds were used to obtain it. Such property is identified in Appendix A, Statement of Work. Personal Property shall be disposed of as directed by the owner at the owner's expense. All jointly funded property shall be owned by the Government.

ARTICLE V: DISCLAIMER

THE GOVERNMENT, THE PARTICIPANT, AND THE CONTRACTOR MAKE NO EXPRESS OR IMPLIED WARRANTY AS TO THE CONDITIONS OF THE RESEARCH OR ANY INTELLECTUAL PROPERTY, GENERATED INFORMATION, OR PRODUCT MADE, OR DEVELOPED UNDER THIS CRADA, OR THE OWNERSHIP, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OF THE RESEARCH OR RESULTING PRODUCT. NEITHER THE GOVERNMENT, THE PARTICIPANT, NOR THE CONTRACTOR SHALL BE LIABLE FOR SPECIAL, CONSEQUENTIAL OR INCIDENTAL DAMAGES ATTRIBUTED TO SUCH RESEARCH OR RESULTING PRODUCT, INTELLECTUAL PROPERTY, GENERATED INFORMATION, OR PRODUCT MADE OR DEVELOPED UNDER THIS CRADA.

ARTICLE VI: PRODUCT LIABILITY

Except for any liability resulting from any negligent acts or omissions of Contractor, Participant indemnifies the Government and the Contractor for all damages, costs and expenses, including attorney's fees, arising from personal injury or property damage occurring as a result of the making, using or selling of a product, process or service by or on behalf of the Participant, its assignees or licensees, which was derived from the work performed under this CRADA. In respect to this Article, neither the Government nor the Contractor shall be considered assignees or licensees of the Participant, as a result of reserved Government and Contractor rights. The indemnity set forth in this paragraph shall apply only if Participant shall have been informed as soon and as completely as practical by the Contractor and/or the Government of the action alleging such claim and shall have been given an opportunity, to the maximum extent afforded by applicable laws, rules, or regulations, to participate in and control its defense, and the Contractor and/or Government shall have provided all reasonably available information and reasonable assistance requested by Participant. No settlement for which Participant would be responsible shall be made without Participant's consent unless required by final decree of a court of competent jurisdiction.

ARTICLE VII: OBLIGATIONS AS TO PROPRIETARY INFORMATION

A. If Proprietary Information is orally disclosed to a Party, it shall be identified as such, orally, at the time of disclosure and confirmed in a written summary thereof, appropriately marked by the disclosing party,within ___ days as being Proprietary Information.

B. Each Party agrees to not disclose Proprietary Information provided by another Party to anyone other than the CRADA Participant and Contractor without written approval of the providing Party, except to Government employees who are subject to the statutory provisions against disclosure of confidential information set forth in the Trade Secrets Act (18 USC 1905).

C. All Proprietary Information shall be returned to the provider thereof at the conclusion of this CRADA at the provider's expense.

D. All Proprietary Information shall be protected for a period of ____ years, unless and until such Proprietary Information shall become publicly known without the fault of the recipient, shall come into recipient's possession without breach of any of the obligations set forth herein by the recipient, or shall be independently developed by recipient's employees who did not have access to such Proprietary Information.

(The following paragraph may be included in this article if desired.)

E. In no case shall the Contractor provide Proprietary Information of Participant to any person or entity for commercial purposes, unless otherwise agreed to in writing by such Participant.

ARTICLE VIII: OBLIGATIONS AS TO PROTECTED CRADA INFORMATION

A. *Each Party may designate as Protected CRADA Information, as defined in Article I, any Generated Information produced by its employees and, with the agreement of the other Party, designate any Generated Information produced by the other Party's employees. All such designated Protected CRADA Information shall be appropriately marked.*

B. *For a period of _____ [not to exceed five years] from the date Protected CRADA Information is produced, Parties agree not to further disclose such Information except:*

(1) *as necessary to perform this CRADA;*

(2) *as provided in Article XI* [REPORTS AND ABSTRACTS];

(3) *as requested by the DOE Contracting Officer to be provided to other DOE facilities for use only at those DOE facilities with the same protection in place;*

(4) *to existing or potential licensees, affiliates, customers or suppliers of the Parties in support of commercialization of the technology with the same protection in place. Disclosure of Participant's Protected CRADA Information under this subparagraph shall only be done with Participant's consent; or*

(5) *as mutually agreed by the Parties in advance.*

C. The obligations of (B) above shall end sooner for any Protected CRADA Information which shall become publicly known without fault of either Party, shall come into a Party's possession without breach by that Party of the obligations of (B) above, or shall be independently developed by a Party's employees who did not have access to the Protected CRADA Information.

ARTICLE IX: RIGHTS IN GENERATED INFORMATION

The Parties agree that they shall have no obligations of non-disclosure or limitations on their use of, and the Government shall have unlimited rights in, all Generated Information, all Protected CRADA Information after the expiration of the period set forth in Article VIII (B) above and information provided to the Government or Contractor under this CRADA which is not marked as being copyrighted (subject to Article XIII) or as Protected CRADA Information (subject to Article VIII B) or Proprietary Information (subject to Article VII B), or which is an invention disclosure which may later be the subject of a U.S. or foreign patent application.

ARTICLE X: EXPORT CONTROL

THE PARTIES UNDERSTAND THAT MATERIALS AND INFORMATION RESULTING FROM THE PERFORMANCE OF THIS CRADA MAY BE SUBJECT TO EXPORT CONTROL LAWS AND THAT EACH PARTY IS RESPONSIBLE FOR ITS OWN COMPLIANCE WITH SUCH LAWS.

ARTICLE XI: REPORTS AND ABSTRACTS

The Parties agree to produce the following deliverables:

(1) an initial abstract suitable for public release at the time the CRADA is approved by DOE;

(2) other abstracts (final when work is complete, and others as substantial changes in scope and dollars occur);

(3) a final report upon completion or termination of this CRADA, to include a list of subject inventions;

(4) a semi-annual signed financial report of the Participant's in-kind contributions to the project;

(5) other topical/periodic reports where the nature of research and magnitude of dollars justify; and

(6) computer software in source and executable object code format as defined within the Statement of Work or elsewhere within the CRADA documentation.

B. It is understood that the Contractor has the responsibility to provide the above information at the time of its completion to the DOE Office of Scientific and Technical Information.

C. Participant agrees to provide the above information to the Contractor to enable full compliance with paragraph B. of this Article.

(DOE has a responsibility to disseminate scientific and technical information, by 42 USC 2051(d), 42 USC 2161(b) and 42 USC 2166(b).)

D. *It is understood that the Contractor and the Department of Energy have a need to document the long-term economic benefit of the cooperative research being done under this agreement. Therefore, the Participant acknowledges a responsibility to respond to reasonable requests, during the term of this CRADA and for a period of* _____ *years* [two to five years would be reasonable] *thereafter from the Contractor for pertinent information.*

ARTICLE XII: PRE-PUBLICATION REVIEW

A. The Parties agree to secure pre-publication approval from each other which shall not be unreasonably withheld or denied beyond ___days.

B. The Parties agree that neither will use the name of the other

Party or its employees in any promotional activity, such as advertisements, with reference to any product or service resulting from this CRADA, without prior written approval of the other Party.

ARTICLE XIII: COPYRIGHTS

A. The Parties may assert copyright in any of their Generated Information. Assertion of copyright generally means to enforce or give any indication of an intent or right to enforce such as by marking or securing Federal registration.

B. [Allocation of rights to Copyrights in Generated Information will be negotiated by the Parties.]

C. For Generated Information, the Parties acknowledge that the Government has for itself and others acting on its behalf, a royalty-free, non-transferable, non-exclusive, irrevocable worldwide copyright license to reproduce, prepare derivative works, distribute copies to the public, and perform publicly and display publicly, by or on behalf of the Government, all copyrightable works produced in the performance of this CRADA, subject to the restrictions this CRADA places on publication of Proprietary Information and Protected CRADA Information.

D. For all copyrighted computer software produced in the performance of this CRADA, the Party owning the copyright will provide the source code, an expanded abstract as described in Appendix C, the executable object code and the minimum support documentation needed by a competent user to understand and use the software to DOE's Energy Science and Technology Software Center, P.O. Box 1020, Oak Ridge, TN 37831. The expanded abstract will be treated in the same manner as Generated Information in subparagraph C of this Article.

E. The Contractor and the Participant agree that, with respect to any copyrighted computer software produced in the performance of this CRADA, DOE has the right, at the end of the period set forth in paragraph B of Article VIII hereof and at the end of each two-year interval thereafter, to request the Contractor and the Participant and any assignee or exclusive licensee of the copyrighted software to grant a non-exclusive, partially exclusive, or exclusive license to a responsible applicant upon terms that are reasonable under the circumstances, provided such grant does not cause a termination of any licensee's right to use the copyrighted computer software. If the Contractor or the Participant or any assignee or exclusive licensee refuses such request, the Contractor and the Participant agree that DOE has the right to grant the license if DOE determines that the Contractor, the Participant, assignee, or licensee has not made a satisfactory demonstration that it is actively pursuing commercialization of the copyrighted computer software. Before requiring licensing under this paragraph E, DOE shall furnish the Contractor/Participant written notice of its intentions to require the Contractor/Participant to grant the stated license, and the Contractor/Participant shall be allowed 30 days (or such longer period as may be authorized by the cognizant DOE Contracting Officer for good cause shown in writing by the Contractor/Participant) after such notice to show cause why the license should not be required to be granted.

The Contractor/Participant shall have the right to appeal the decision by the DOE to the grant of the stated license to the Invention Licensing Appeal Board as set forth in paragraphs (b)-(g) of 10 CFR 781.65, "Appeals".

F. The Parties agree to place Copyright and other notices, as appropriate for the protection of Copyright, in human readable form onto all physical media, and in digitally encoded form in the header of machine readable information recorded on such media such that the notice will appear in human readable form when the digital data are off loaded or the data are accessed for display or printout.

ARTICLE XIV: REPORTING SUBJECT INVENTIONS

A. The Parties agree to disclose to each other each and every Subject Invention, which may be patentable or otherwise protectable under the Patent Act. The Parties acknowledge that the Contractor and Participant will disclose their respective Subject Inventions to the DOE within two (2) months after the inventor first discloses the Subject Invention in writing to the person(s) responsible for patent matters of the disclosing Party.

B. These disclosures should be in sufficiently complete technical detail to convey a clear understanding, to the extent known at the time of the disclosure, of the nature, purpose and operation of the Subject Invention. The disclosure shall also identify any known actual or potential statutory bars, i.e., printed publications describing the Subject Invention or the public use or on sale of the Subject Invention in this country. The Parties further agree to disclose to each other any subsequent known actual or potential statutory bar that occurs for an Subject Invention disclosed but for which a patent application has not been filed. All Subject Invention disclosures shall be marked as confidential under 35 USC 205.

ARTICLE XV: TITLE TO INVENTIONS

Whereas the Participant and the Contractor have been granted the right to elect to retain title to Subject Inventions:

A. [Allocation of rights will be negotiated by the Parties.]

B. The Parties acknowledge that the DOE may obtain title to each Subject Invention reported under Article XIV for which a patent application or applications are not filed pursuant to

Article XVI and for which any issued patents are not maintained by any Party to this CRADA.

C. The Parties acknowledge that the Government retains a non-exclusive, non-transferrable, irrevocable, paid-up license to practice or to have practiced for or on behalf of the United States every Subject Invention under this CRADA throughout the world.

ARTICLE XVI: FILING PATENT APPLICATIONS

A. The Parties agree that the Party initially indicated as having an ownership interest in any Subject Inventions (Inventing Party) shall have the first opportunity to file U.S. and foreign patent applications. If the Participant does not file such applications within one year after election, or if the Contractor does not file such applications within the filing time specified in its prime contract, then the other Party to this CRADA exercising an option pursuant to Article XV may file patent applications on such Subject Inventions. If a patent application is filed by the other party (Filing Party), the Inventing Party shall reasonably cooperate and assist the Filing Party, at the Filing Party's expense, in executing a written assignment of the Subject Invention to the Filing Party and in otherwise perfecting the patent application, and the Filing Party shall have the right to control the prosecution of the patent application. The Parties shall agree between themselves as to who will file patent applications on any joint Subject Invention.

B. The Parties agree that DOE has the right to file patent applications in any country if neither Party desires to file a patent application for any Subject Invention. Notification of such negative intent shall be made in writing to the DOE Contracting Officer within three (3) months of the decision of the non-inventing party to not file a patent application for the Subject Invention pursuant to Article XV, or not later than 60 days prior to the time when any statutory bar might foreclose filing of a U.S. patent application.

ARTICLE XVII: TRADEMARKS

The Parties may seek to obtain Trademark/Service Mark protection on products or services generated under this agreement in the United States or foreign countries. [The ownership and other rights relating to this Trademark shall be as mutually agreed to in writing by the Parties.] The Parties hereby acknowledge that the Government shall have the right to indicate on any similar goods or services produced by or for the Government that such goods or services were derived from and are a DOE version of the goods or services protected by such Trademark/Service Mark with the Trademark and the owner thereof being specifically identified. In addition, the Government shall have the right to use such Trademark/Service Mark in print or communications media.

ARTICLE XVIII: MASK WORKS

The Parties may seek to obtain legal protection for Mask Works fixed in semiconductor products generated under this agreement as provided by Chapter 9 of Title 17 of the United States Code. [The rights to any Mask Work covered by this provision shall be as mutually agreed to in writing by the Parties.] The Parties hereby acknowledge that the Government or others acting on its behalf shall retain a non-exclusive, paid-up, worldwide, irrevocable, non-transferable license to reproduce, import, or distribute the covered semiconductor product by or on behalf of the Government, and to reproduce and use the Mask Work by or on behalf of the Government.

ARTICLE XIX: COST OF INTELLECTUAL PROPERTY PROTECTION

Each Party shall be responsible for payment of all costs relating to Copyright, Trademark and Mask Work filing, U.S. and foreign patent application filing and prosecution, and all costs relating to maintenance fees for U.S. and foreign patents hereunder which are solely owned by that Party. Government/DOE laboratory funds contributed as DOE's cost share to a CRADA cannot be given to Participant for payment of Participant's costs of filing and maintaining patents or filing for Copyrights, Trademarks and Mask Works.

ARTICLE XX: REPORTS OF INVENTION USE

Participant agrees to submit, for a period of ____ years and upon request of DOE, a non-proprietary report no more frequently than annually on efforts to utilize any Intellectual Property arising under the CRADA.

ARTICLE XXI: DOE MARCH-IN RIGHTS

The Parties acknowledge that the DOE has certain march-in rights to any Subject Inventions in accordance with 48 CFR 27.304-1(g).

ARTICLE XXII: U.S. COMPETITIVENESS

The Parties agree that a purpose of this CRADA is to provide substantial benefit to the U.S. economy.

In exchange for the benefits received under this CRADA, the Participant therefore agrees to the following:

A. Products embodying Intellectual Property developed under this CRADA shall be substantially manufactured in the United States;

B. Processes, services, and improvements thereof which are covered by Intellectual Property developed under this CRADA shall be incorporated into the Participant's manufacturing facilities in the United States either prior to or simultaneously with implementation outside the United States. Such processes, services, and improvements, when implemented outside the U.S., shall not result in reduction of the use of the same processes, services, or improvements in the United States; and

C. The Contractor agrees to a U.S. Industrial Competitiveness clause in accordance with its prime contract with respect to any licensing and assignments of its intellectual property arising from this CRADA, except that any licensing or assignment of its intellectual property rights to the Participant shall be in accordance with the terms of Paragraphs A. and B. of this Article.

ARTICLE XXIII: ASSIGNMENT OF PERSONNEL

A. It is contemplated that each Party may assign personnel to the other Party's facility as part of this CRADA to participate in or observe the research to be performed under this CRADA. Such personnel assigned by the assigning Party shall not during the period of such assignments be considered employees of the receiving Party for any purposes.

B. The receiving Party shall have the right to exercise routine administrative and technical supervisory control of the occupational activities of such personnel during the assignment period and shall have the right to approve the assignment of such personnel and/or to later request their removal by the assigning Party.

C. The assigning Party shall bear any and all costs and expenses with regard to its personnel assigned to the receiving Party's facilities under this CRADA. The receiving Party shall bear facility costs of such assignments.

ARTICLE XXIV: FORCE MAJEURE

No failure or omission by Contractor or Participant in the performance of any obligation under this CRADA shall be deemed a breach of this CRADA or create any liability if the same shall arise from any cause or causes beyond the control of Contractor or Participant, including but not limited to the following, which, for the purpose of this CRADA, shall be regarded as beyond the control of the Party in question: Acts of God, acts or omissions of any government or agency thereof, compliance with requirements, rules, regulations, or orders of any governmental authority or any office, department, agency, or instrumentality thereof, fire, storm, flood, earthquake, accident, acts of the public enemy, war, rebellion, insurrection, riot, sabotage, invasion, quarantine, restriction, transportation embargoes, or failures or delays in transportation.

ARTICLE XXV: ADMINISTRATION OF CRADA

It is understood and agreed that this CRADA is entered into by the Contractor under the authority of its prime Contract with DOE. The Contractor is authorized to and will administer this CRADA in all respects unless otherwise specifically provided for herein. Administration of this CRADA may be transferred from the Contractor to DOE or its designee with notice of such transfer to the Participant, and the Contractor shall have no further responsibilities except for the confidentiality, use and/or non-disclosure obligations of this CRADA.

ARTICLE XXVI: RECORDS AND ACCOUNTING FOR GOVERNMENT PROPERTY

The Participant shall maintain records of receipts, expenditures, and the disposition of all Government property in its custody related to the CRADA.

ARTICLE XXVII: NOTICES

A. Any communications required by this CRADA, if given by postage prepaid first class U.S. Mail or other verifiable means addressed to the Party to receive the communication, shall be deemed made as of the day of receipt of such communication by the addressee, or on the date given if by verified facsimile. Address changes shall be given in accordance with this Article and shall be effective thereafter. All such communications, to be considered effective, shall include the number of this CRADA.

B. The addresses, telephone numbers and facsimile numbers for the Parties are as follows:

ARTICLE XXVIII: DISPUTES

The Parties shall attempt to jointly resolve all disputes arising from this CRADA. If the Parties are unable to jointly resolve a dispute within a reasonable period of time, they agree to [Process to be negotiated by the Parties]. To the extent that there is no applicable U.S. Federal law, this CRADA and performance thereunder shall be governed by the law of the State of ________

ARTICLE XXIX: ENTIRE CRADA AND MODIFICATIONS

A. It is expressly understood and agreed that this CRADA with its Appendices contains the entire agreement between the Parties with respect to the subject matter hereof and that all prior representations or agreements relating hereto have been merged into this document and are thus superseded in totality by this CRADA. This CRADA shall not be effective until approved by DOE.

B. Any agreement to materially change any terms or conditions of this CRADA or the Appendices shall be valid only if the change is made in writing, executed by the Parties hereto, and approved by DOE.

ARTICLE XXX: TERMINATION

This CRADA may be terminated by either Party upon ___days written notice to the other Party. This CRADA may also be terminated by the Contractor in the event of failure by the Participant to provide the necessary advance funding, as agreed in Article III.

In the event of termination by either Party, each Party shall be responsible for its share of the costs incurred through the effective date of termination, as well as its share of the costs incurred after the effective date of termination, and which are related to the termination. The confidentiality, use, and/or non-disclosure obligations of this CRADA shall survive any termination of this CRADA.

FOR CONTRACTOR:

BY________________________________

TITLE_____________________________

DATE______________________________

FOR PARTICIPANT:

BY________________________________

TITLE_____________________________

DATE ______________________________

Q6. **You also stated on page 3 of your prepared testimony that "[g]eneral policy guidance and approved terms and conditions are set forth in the "Modular CRADA" which is made available to the contractors, contracting officers and the public."**

Please provide a copy of these documents.

A6. Attached is a copy of the text of the DOE Modular CRADA, which includes general policy guidance and approved terms and conditions.

DOE-APPROVED CRADA LANGUAGE AND GUIDANCE

December 14, 1995

TABLE OF CONTENTS

Page

1: Introduction to the DOE Modular CRADA
2: The DOE Sample CRADA
2: Negotiating and Approving CRADAs
3: The Importance of Teamwork and Communications

DOE-APPROVED CRADA LANGUAGE AND GUIDANCE

5: TITLE OF CRADA
6: Article I: DEFINITIONS
10: Article II: STATEMENT OF WORK
11: Article III: TERM, FUNDING AND COSTS
15: Article IV: PERSONAL PROPERTY
16: Article V: DISCLAIMER
17: Article VI: PRODUCT LIABILITY
24: Article VII: OBLIGATIONS AS TO PROPRIETARY INFORMATION
29: Article VIII: OBLIGATIONS AS TO PROTECTED CRADA INFORMATION
34: Article IX: RIGHTS IN GENERATED INFORMATION
35: Article X: EXPORT CONTROL
36: Article XI: REPORTS AND ABSTRACTS
39: Article XII: PRE-PUBLICATION REVIEW
41: Article XIII: COPYRIGHTS
47: Article XIV: REPORTING SUBJECT INVENTIONS
50: Article XV: TITLE TO SUBJECT INVENTIONS
52: Article XVI: FILING PATENT APPLICATIONS
59: Article XVII: TRADEMARKS
57: Article XVIII: MASK WORKS
58: Article XIX: COST OF INTELLECTUAL PROPERTY PROTECTION
59: Article XX: REPORTS OF INTELLECTUAL PROPERTY USE
60: Article XXI: DOE MARCH-IN RIGHTS
61: Article XXII: U.S. COMPETITIVENESS
64: Article XXIII: ASSIGNMENT OF PERSONNEL
67: Article XXIV: FORCE MAJEURE
68: Article XXV: ADMINISTRATION OF THE CRADA
69: Article XXVI: RECORDS AND ACCOUNTING FOR GOVERNMENT PROPERTY
70: Article XXVII: NOTICES
73: Article XXVIII: DISPUTES
76: Article XXIX: ENTIRE CRADA AND MODIFICATIONS
78: Article XXX: TERMINATION
80: Article ___ PROJECT MANAGEMENT
81: Article ___ ORDER OF PRECEDENCE
81: Article ___ WAIVER

Documents Section:

82: Appendix A: Procedure for Foreign Ownership, Control and Influence review
90: Appendix B: U.S. Competitiveness Work Sheet
91: Appendix C: Format for Expanded Software Abstract
93: Appendix D: The DOE Sample CRADA

Introduction

This document, to be referred to as the Department of Energy (DOE) Modular Cooperative Research and Development Agreement (CRADA), is a compendium of provisions which may be drawn upon for crafting CRADAs. It has been developed to be responsive to the needs of different CRADA Participants while protecting the interests of the Government and the U.S. taxpayers and is a tool for DOE and its Government-Owned Contractor-Operated (GOCO) laboratories, hereafter referred to as laboratories, to facilitate the negotiation, development and timely approval of CRADAs.

This Modular CRADA incorporates three types of provisions:

(1) Those few that are required by statute or policy, [set off by double underscore] are strongly recommended for timely approval, and can only be changed with DOE Headquarters approval. Changing double underscored language or examples may delay the process. Double underscored language can be eliminated where it doesn't apply, such as, for example the deletion of the definition of "Subject Invention" where it is not anticipated that there will be any subject inventions under the CRADA.

(2) Those that sound judgment suggests have a valid basis for being included in the terms and conditions of the CRADA, consistent with the guidelines incorporated herein. These can be modified in one of three ways:

- by using the pre-approved options provided in the guidance;
- by modifying the language without changing its substantive meaning; and
- by negotiating the language that changes its substantive meaning, or even deleting the language with appropriate justification; in each of these two instances, Operations Office or Field Office approval is required.

(3) Those that are left solely to the negotiations between the laboratory and the Participants. [Shown in brackets.]

Through a spirit of teamwork and a policy of "no surprises," this document should enable DOE and its laboratories to be responsive to a broad range of Participant needs. This approach is intended to convey the maximum flexibility in CRADA development, and in speed of negotiations and approval, while fostering consistency across DOE and its laboratories.

In drafting a CRADA from the options provided in the Modular CRADA, the laboratory should be careful not to create internal conflicts within the agreement. The draft CRADA should still follow the form (i.e., order of provisions) of the DOE Modular CRADA in order to facilitate Operations Office or Field Office review and approval.

In this document, the format for presenting the various provisions of the CRADA will consist of:

- a statement of the article, with language required by statute or policy double underscored;
- a rationale for the article; and
- pre-approved optional provisions for the article (set off inside a box).

Example:

Article 1 (Title)
- Required provisions (if any)
  - rationale or basis for requirement
- Pre-approved optional provisions (if any)
  - rationale/appropriate circumstances
- Pre-approved optional provisions #2
  - rationale/appropriate circumstances
- Bracketed provisions
  - rationale/explanation, or to
- General Guidance

The Sample CRADA

A sample DOE CRADA, which is attached, incorporates the double underscore provisions and some of the more common optional provisions provided in the Modular CRADA. It is a tool for communicating DOE's general requirements and expectations to potential Participants in a clear and consistent manner. The sample DOE CRADA should be provided to potential Participants as the first hand-out in all instances, such as at conferences and trade shows and DOE sponsored events. When the sample DOE CRADA is used for these purposes, it may be modified only to the extent that the laboratory name is inserted, or to conform to individual Management and Operating Contracts. It may be supplemented by a copy of a Laboratory-specific model CRADA indicating the Contractor's standard preferences for application of the DOE-approved modular language. This laboratory-specific model must be approved by the DOE Operations or Field Office.

Negotiating and Approving CRADAs

By law and through prime contract provisions, the laboratories have been delegated the authority and responsibility for negotiating the CRADA, including a Statement of Work. In exercising that authority, laboratories need to strike a balance between consistency and flexibility.

To the extent the negotiated CRADA uses language that does not deviate from the double underlined provisions and uses the pre-approved optional provisions, the Operations Office or Field Office review and approval of the CRADA will be faster.

The Operations Offices or Field Offices are the approval authority for Joint Work Statements (JWSs) and CRADAs. To facilitate Operations Office or Field Office review, laboratories should identify all deviations from the double underlined provisions or pre-approved optional provisions at the time the CRADA is submitted for approval. It is recommended that two proposed CRADA versions be submitted by the laboratories to the Operations Office or Field Office - one which highlights all deviations from the Modular CRADA provisions using "redline" and "strikeout" features and one which is a "clean" version. All deviations which are considered by the laboratories to be substantive should be supported by appropriate justification. Any deviation from the double underlined provisions requires approval of DOE Headquarters. After receiving any proposed deviations to double underscored language from a laboratory, the Operations Office or Field Office will transmit the language and reasons for the requested deviation to the Headquarters office designated by the Deputy Secretary, the staff of which will confer with the appropriate elements in Headquarters in determining if the requested deviation is acceptable and inform the Operations Office or Field Office of the Headquarters' determination. Any deviations from the pre-approved optional provisions, except for deviations to double underscored language which must be approved by Headquarters, requires review and approval by the Operations Office or Field Office. In the case of changes from the pre-approved optional provisions which the Operations Office or Field Office agrees are non-substantive, such approval may be reflected merely by approval of the CRADA. In the case of substantive changes, specific approval in the form of a notation on the "redline" version, or other supporting documents, will suffice. Any requests for modification of the CRADA by the Operations Office or Field Office to the laboratory must comply with the requirements of 15 USC 3710a(c)(5)(C).

While available for consultation to both the laboratory and the prospective Participant, the Operations Office or Field Office should refrain from becoming a third party to the negotiations. Each Operations Office or Field Office is encouraged to designate a single point of contact to facilitate the CRADA review and approval process at the Operations Office or Field Office. Like the Operations Office or Field Offices, program offices and others should refrain from becoming a third party to the negotiations between the laboratory and the prospective Participant.

The Importance of Teamwork and Communication

In order to use this document effectively, close cooperation and communication between the laboratory and DOE is essential. Issues that can be foreseen as key issues, especially critical departures from pre-approved language, should be discussed as early as possible. There should be a minimum of surprises in the process. At the same time, the laboratory and DOE should be open to proposed changes from Participants where the changes help the process of negotiation but do not infringe upon the Government's rights. When alternative language is clearly called for, such alternative language should be used. One of the objectives of this document is to provide pre-approved alternative language for different situations, as well as guidance and rationale for using that alternative language.

The DOE Modular CRADA will be updated on a routine basis to incorporate new language and alternatives, based on input from the Participants, laboratories, Operations Office or Field Offices, and DOE programs. Laboratory staff with proposed updates should contact their Operations Office or Field Office, and Operations Office or Field Office staff with proposed updates should contact the Headquarters office designated by the Deputy Secretary to receive such.

The following points should be addressed in a CRADA as minimum guidance for an effective CRADA. The attached DOE Sample CRADA is the basic set of CRADA provisions; other clauses are provided in the Guidance to accommodate different arrangements between Contractors and Participants. Many of the specific articles and clauses are negotiable between the Parties.

TITLE OF CRADA

Language:

STEVENSON-WYDLER (15 USC 3710)
COOPERATIVE RESEARCH AND DEVELOPMENT
AGREEMENT (hereinafter "CRADA") No. _____

BETWEEN

____

under its U.S. Department of Energy Contract

No. __________ (hereinafter "Contractor")

AND

______________________ (hereinafter "Participant"),

both being hereinafter jointly referred to as the "Parties"

General Guidance

The CRADA number and names of the Parties to the CRADA must included in the CRADA immediately preceding Article I; Definitions.

ARTICLE I: DEFINITIONS

LANGUAGE:

A. *"Government" means the United States of America and agencies thereof.*

B. *"DOE" means the Department of Energy, an agency of the United States of America.*

C. *"Contracting Officer" means the DOE employee administering the Contractor's DOE contract.*

D. *"Generated Information" means information produced in the performance of this CRADA.*

(Policy definition)

E. *"Proprietary Information" means information which embodies (i) trade secrets or (ii) commercial or financial information which is privileged or confidential under the Freedom of Information Act (5 USC 552 (b)(4)), either of which is developed at private expense outside of this CRADA and which is marked as Proprietary Information.*

(based on 15 USC 3710a(c)(7)(A))

OPTION

E. *"Proprietary Information" means information which is developed at private expense outside of this CRADA, is marked as Proprietary Information, and embodies (i) trade secrets or (ii) commercial or financial information which is privileged or confidential under the Freedom of Information Act (5 USC 552 (b)(4)).*

GUIDANCE: **Alternative language which may be used if desired.**

F. *"Protected CRADA Information" means Generated Information which is marked as being Protected CRADA Information by a Party to this CRADA and which would have been Proprietary Information had it been obtained from a non-federal entity.*

(based on 15 USC 3710a(c)(7)(B))

G. *Subject Invention means any invention of the Contractor or Participant conceived or first actually reduced to practice in the performance of work under this CRADA.*

(based on 35 USC 201(e))

H. *"Intellectual Property" means Patents, Trademarks, Copyrights, Mask Works, Protected CRADA Information and other forms of comparable property rights protected by Federal Law and other foreign counterparts.*

OPTION

H. *"Intellectual Property" means Patents, Copyrights, Trademarks and Mask Works protected by Federal Law and foreign counterparts.*

GUIDANCE: Alternative language which may be used if desired.

I. *"Trademark" means a distinctive mark, symbol or emblem used in commerce by a producer or manufacturer to identify and distinguish its goods or services from those of others.*

J. *"Service Mark" means a distinctive word, slogan, design, picture, symbol or any combination thereof, used in commerce by a person to identify and distinguish its services from those of others.*

K. *"Mask Work" means a series of related images, however fixed or encoded, having or representing the predetermined, three-dimensional pattern of metallic, insulating or semiconductor material present or removed from the layers of a semiconductor chip product; and in which series the relation of the images to one another is that each image has the pattern of the surface of one form of the semiconductor chip product. (17 USC 901(a)(2)).*

L. *"RD&D" means research, development and demonstration performed by the Contractor and the Participant under this CRADA, including works performed by consultants or other contractors and subcontractors under this CRADA.*

M. *"Background Intellectual Property" means the Intellectual Property rights in the items identified by* *the Parties in Appendix D, Background Intellectual Property, which were in existence prior to or are first produced outside of this CRADA, except that in the case of inventions in those identified items, the inventions must have been conceived outside of this CRADA and not first actually reduced to practice under this CRADA to qualify as Background Intellectual Property. Licensing of Background Intellectual Property, if agreed to by the Parties, shall be the subject of separate licensing agreements between the Parties. Background Inventions are not Subject Inventions.*

[When the need for a FOCI review has been determined to exist and where Article X has been appropriately modified, the following definitions should be added:]

N. Foreign Interest is defined as any of the following:

(1) A foreign government or foreign government agency;

(2) Any form of business enterprise organized under the laws of any country other than the United States or its possessions;

(3) Any form of business enterprise organized or incorporated under the laws of the United States, or a State or other jurisdiction within the United States, which is owned, controlled, or influenced by a foreign government, agency, firm, corporation or person; or

(4) Any person who is not a U. S. citizen.

O. Foreign ownership, control, or influence (FOCI) means the situation where the degree of ownership, control, or influence over a participant by a foreign interest is such that a reasonable basis exists for concluding that compromise of classified information or special nuclear material, as defined in 10 CFR Part 710, may result.

GENERAL GUIDANCE:

A definition section must include one for the DOE Contracting Officer, DOE, Generated Information, Subject Invention and any other terms that would be used in the CRADA. If the CRADA is expected to involve Proprietary Information being furnished and/or Protected CRADA Information being generated, these definitions must be included. The DOE Sample CRADA includes the most frequently used definitions.

The definition for Background Intellectual Property may not be all inclusive (e.g., preexisting invention disclosures or unregistered copyrighted software). It is essential that the existence of this additional background intellectual property be brought to the attention of the other party before the CRADA is signed. This can be done by either changing the definition or by using a separate document, such as the Joint Work Statement, to recognize such background intellectual property.

If a defined term is not relevant for a particular CRADA, the definition may be deleted so long as the relevant provisions are appropriately modified (i.e., if the Statement of Work does not contemplate the creation of Mask Works, then Article XVIII should be reserved by so indicating in [brackets] and the definition of Mask Works should be deleted from the definition section. This will avoid the need to renumber all of the articles after Article XVII.) The Parties may incorporate additional definitions into the CRADA. An example of a common definition that may be needed is the following:

o "CRADA" means a Cooperative Research and Development Agreement.

ARTICLE II: STATEMENT OF WORK

LANGUAGE:

Appendix A, Statement of Work, is hereby incorporated into this CRADA by reference.

OR

Appendix A is the Statement of Work.

GENERAL GUIDANCE:

There must be a Statement of Work. It must include a technical description of the scope encompassed by the proposed CRADA, as well as who the principal investigators will be for each Party, who will provide what funds, personnel, services, property, who will do what reporting on the work, impacts on the DOE program, and procedures for interaction between the Parties to accomplish the Statement of Work, which is the objective of the CRADA. The effective date of the CRADA and the term of the CRADA may be included in the Statement of Work. Any background rights that are affected must be addressed, here or elsewhere. Any environmental, health and safety issues must be handled, here or elsewhere, particularly if there is any exchange of materials, equipment, or other tangible property. Any Proprietary Information included in the Statement of Work should be clearly marked. Do not incorporate proprietary information in the Statement of Work unless the Parties consider it absolutely necessary to define the work.

ARTICLE III: TERM, FUNDING AND COSTS

LANGUAGE:

A. The effective date of this CRADA shall be the latter date of (1) the date on which it is signed by the last of the Parties hereto or (2) the date on which it is approved by DOE. The work to be performed under this CRADA shall be completed within ________ months/years from the effective date.

B. The Participant's estimated contribution is $______. The Government's estimated contribution, which is provided through the Contractor's contract with DOE, is $_____, subject to available funding.

(based on 31 USC 1341(a)(1): Anti-Deficiency Act, as well as Departmental policy)

OPTION

LANGUAGE:

B. The total estimated project cost is $__________, of which the total Government estimated contribution of $__________ is provided through the Contractor's contract with DOE, subject to available funds; the Participant's estimated contribution is $__________; and the other Participant(s) estimated contribution is $__________

GUIDANCE; This option may be used in the instance of a number of different Participants working on the same project under separate CRADAs.

C. Neither Party shall have an obligation to continue or complete performance of its work at a contribution in excess of its estimated contribution as contained in Article III A above, including any subsequent amendment.

D. Each Party agrees to provide at least ___days' notice to the other Party if the actual cost to complete performance will exceed its estimated cost.

OPTION

D. Notification to all Parties that actual costs will substantially exceed estimated costs shall be provided by any Party who makes such determination. Such notification shall take place as soon as possible after making such determination, but not later than 30 days prior to termination based on such cause. If the Parties mutually agree to continue the project, subject to Article XXIX [ENTIRE CRADA AND MODIFICATIONS]*, the estimated cost shall be appropriately amended and the Parties shall agree on the share of each Party of such increase in estimated cost by duly executed amendments to this CRADA.*

GUIDANCE: Alternative language which may be used if desired. This is a management tool to catch large deviations. It is not intended that this would come into play for minor deviations from estimated cost.

[E. For CRADAs which include (non-Federal) funding on a funds-in basis, an advance payment provision will be negotiated consistent with current DOE policy.]

The following examples represent a range of alternative advance payment provisions that can be used for Paragraph D if necessary. They are all consistent with current DOE policy on requiring advance payments, as elaborated in the DOE Acting Chief Financial Officer's (CFO) memorandum of August 4, 1992, "Guidance on Advance Funding Under Cooperative Research and Development Agreements (CRADAs)." Some are appropriate only for specific types of Participants.

Option 1 -- Recommended provision to be used for most Participants, where the work is greater than $25,000 and will last longer than 90 days. Advance payments in this option are to be calculated on a 90-day basis.

E. Sufficient advance funds shall be obtained to maintain approximately a 90-day advance of funds during the entire period of work covered by the funds provided by the Participant under the CRADA. No work will begin *before the receipt of a cash advance. Failure of Participant to provide the necessary advance funding is cause for termination of the CRADA in accordance with the Termination article of the CRADA.*

Option 2 -- Where the Participant's contribution in direct funds to the Contractor is $25,000 or less or where the work will be completed in 90 days or less:

E. *Full funding is required prior to beginning work covered by funds provided by the Participant under the CRADA.*

Option 3 -- For small businesses that are unable to meet the 90-day advance payment requirement, the Contractor may negotiate a shorter time period (applicable to Option 1 above).

Option 4 -- The Contractor performing the work may elect to provide the advance funding from their award/management fees, royalties, or other non-federal corporate funds.

Option 5 -- Recommended provision when it is not feasible for certain Participants to provide a cash advance; who cannot fulfill the advance payment requirements of Options 1 or 2 (only for a small or disadvantaged business currently not in a position to lose interest on advanced funds for an extended period of time). Refer to the DOE Accounting Handbook, Chapter 13, paragraph 5b for appropriate instructions for accounting procedure for this option.

E. *Upon execution of this CRADA, Participant shall have established an irrevocable trust or escrow account. The balance in this account must be maintained at a level equivalent to approximately a 90-day advance of funds during the life of the CRADA. Accrued costs and commitments of the Participant shall not exceed the balance in the trust or escrow account plus the payments received from the Participant.*

Option 6 -- For State or local governments with a statute or other legal prohibition to advancing funds, no advance funding provision is required. Refer to the DOE Accounting Handbook, Chapter 13, paragraph 5b for appropriate instructions for accounting procedures for this option.

GENERAL GUIDANCE:

There must be a statement of funding for the CRADA, showing the estimated contributions of the Parties. The statement must clearly state that the Government's estimated contribution is provided through the Contractor's contract with DOE and is subject to available funding. The statement may indicate that Participant's contributions are also subject to availability of funds. It should also include provisions that describe the obligations of the Parties relative to exceeding the estimated costs.

The statement must include a provision addressing advance payment requirements whenever there are "funds in" from the Participant. The Contractor may not agree to waive advance payments unless the Contractor is using its own funds (e.g., from royalties). The Contractor may, however, negotiate variations to the standard advance payment requirement for small businesses and others, consistent with DOE policy and financial guidance. Several example clauses are found below.

Parties may also wish to set forth levels of commitment to the CRADA, in terms of Full-Time Equivalent numbers of various staff and personnel classifications.

If it is determined that DOE added factor and depreciation charges, which would otherwise be payable on any funds-in by the Participant, are to be considered as a part of DOE's contribution to the CRADA, appropriate disclosure must be made under this Article (i.e., "In addition, the Government is contributing $_____ in waived DOE added factor and depreciation costs which would otherwise be payable by the Participant."). [reworded]

Program offices may provide supplemental guidance on funding and other issues to the Contractor and Operations Office or Field Office to help avoid surprises as well as to ensure effective coordination of CRADAs and management of multi-year resource requirements.

Under current DOE policy, funds previously obtained from federal sources can be used to finance a non-federal Participant's share of a project. One of the purposes of CRADAs is to stimulate private investment in collaborations with laboratories. It is important that the overall program be supported with significant private funds. However, the Department generally is unconcerned if the funds for the partner's share of a specific CRADA came ultimately from some other Federal program, so long as the decision process for obtaining those funds preceded the final CRADA negotiation and the obtaining of those funds complied with the rules of that process. If the funds came from some other part of the Department, then extra care must be taken to ensure that there has been no real or apparent conflict of interest and that there has been fairness of opportunity.

Other contractual obligations of the Participant with respect to the Government are not overridden by this CRADA.

ARTICLE IV: PERSONAL PROPERTY

LANGUAGE:

All tangible personal property produced or acquired under this CRADA shall become the property of the Participant or the Government depending upon whose funds were used to obtain it. Such property is identified in Appendix A, Statement of Work. Personal Property shall be disposed of as directed by the owner at the owner's expense. All jointly funded property shall be owned by the Government.

OPTION

All tangible personal property produced or acquired under this CRADA (specifically excluding Intellectual Property rights, Background Intellectual Property, and Proprietary Information) shall become the property of the Participant or the Government depending upon whose funds were used to obtain it. Such property is identified in Appendix A, Statement of Work. Personal Property shall be disposed of as directed by the owner at the owner's expense. There shall not be any jointly funded property under this CRADA except by the mutual agreement of the Parties.

GUIDANCE: Alternative language which may be used if desired.

GENERAL GUIDANCE:

There must be agreement among the Parties as to who will retain what tangible property, if any is to be obtained, acquired, produced or modified in the course of the CRADA. Remember that Government property disposal regulations pertain to any property in which Government money is involved.

ARTICLE V: DISCLAIMER

LANGUAGE:

> *THE GOVERNMENT, THE PARTICIPANT, AND THE CONTRACTOR MAKE NO EXPRESS OR IMPLIED WARRANTY AS TO THE CONDITIONS OF THE RESEARCH OR ANY INTELLECTUAL PROPERTY, GENERATED INFORMATION, OR PRODUCT MADE, OR DEVELOPED UNDER THIS CRADA, OR THE OWNERSHIP, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OF THE RESEARCH OR RESULTING PRODUCT. NEITHER THE GOVERNMENT, THE PARTICIPANT, NOR THE CONTRACTOR SHALL BE LIABLE FOR SPECIAL, CONSEQUENTIAL OR INCIDENTAL DAMAGES ATTRIBUTED TO SUCH RESEARCH OR RESULTING PRODUCT, INTELLECTUAL PROPERTY, GENERATED INFORMATION, OR PRODUCT MADE OR DEVELOPED UNDER THIS CRADA.*

OPTION

> *THE GOVERNMENT, THE PARTICIPANT AND THE CONTRACTOR MAKE NO EXPRESS OR IMPLIED WARRANTY AS TO THE CONDITIONS OF THE RESEARCH OR ANY INTELLECTUAL PROPERTY, GENERATED INFORMATION, OR PRODUCT MADE OR DEVELOPED UNDER THIS CRADA, OR THE OWNERSHIP, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OF THE RESEARCH OR RESULTING PRODUCT. NEITHER THE GOVERNMENT, THE PARTICIPANT, NOR THE CONTRACTOR SHALL BE LIABLE FOR LOST PROFITS, LOST SAVINGS, SPECIAL, CONSEQUENTIAL, INCIDENTAL OR OTHER INDIRECT DAMAGES, EVEN IF SUCH PARTY IS MADE AWARE OF THE POSSIBILITY THEREOF.*

GUIDANCE: Alternative language which may be used as desired. Adds in lost profits and savings and provides that Parties are not liable for special, consequential, incidental, or other indirect damages even if they are made aware of the possibility of such damages.

GENERAL GUIDANCE:

There must be a disclaimer of express or implied warranties as to the conduct of this research. This statement should be in the form of a Uniform Commercial Code (UCC)-type disclaimer, which should be conspicuous in the CRADA so as to meet the standards of due notice to the Parties. One way to do this is to use bold type, all capital letters, or to have an especially large type font specifying the disclaimer.

ARTICLE VI: PRODUCT LIABILITY

LANGUAGE:

Except for any liability resulting from any negligent acts or omissions of Contractor, Participant indemnifies the Government and the Contractor for all damages, costs and expenses, including attorney's fees, arising from personal injury or property damage occurring as a result of the making, using or selling of a product, process or service by or on behalf of the Participant, its assignees or licensees, which was derived from the work performed under this CRADA. In respect to this Article, neither the Government nor the Contractor shall be considered assignees or licensees of the Participant, as a result of reserved Government and Contractor rights. The indemnity set forth in this paragraph shall apply only if Participant shall have been informed as soon and as completely as practical by the Contractor and/or the Government of the action alleging such claim and shall have been given an opportunity, to the maximum extent afforded by applicable laws, rules, or regulations, to participate in and control its defense, and the Contractor and/or Government shall have provided all reasonably available information and reasonable assistance requested by Participant. No settlement for which Participant would be responsible shall be made without Participant's consent unless required by final decree of a court of competent jurisdiction.

OPTION 1: Use Of Hold Harmless Provision

As an option to using the above language for product liability,a hold harmless provision may be substituted therefor, such as the following:

> *Except for any liability resulting from any negligent acts or omissions of Contractor, Participant agrees to hold harmless the Government and the Contractor for all damages, costs and expenses, including attorney's fees, arising from personal injury or property damage occurring as a result of the making, using or selling of a product, process or service by or on behalf of the Participant, its assignees or licensees, which was derived from the work performed under this CRADA.*

OPTION 2: Assumption Of Responsibility By Contractor And/Or Participant For Product Liability Claims

The Contractor and/or Participant may voluntarily agree to accept all or some of the risks associated with product liability claims. If the Contractor or Participant accept these risks, the Department will not indemnify either of them for any liability related to product liability claims. Paragraph (c) below discusses this situation. The following clause, appropriately modified to identify the indemnifying parties and/or the degree of their respective obligations, may be used for Article VI:

> *The Participant and/or Contractor indemnify the Government for all damages, costs and expenses, including attorney's fees, arising from personal injury or property damage occurring as a result of the making, using or selling of a product, process or service by or on behalf of the Participant, its assignees or licensees, which was derived from the work performed under this CRADA. In respect to this Article, the Government shall not be considered an assignee or licensee of the Participant or Contractor, as a result of reserved Government rights. The indemnity set forth in this paragraph shall apply only if Participant shall have been informed as soon and as completely as practical by the Government of any action against the Government alleging such claim and shall have been given an opportunity, to the maximum extent afforded by applicable laws, rules, or regulations, to participate in and control its defense, and the Government shall have provided all reasonably available information and reasonable assistance requested by Participant or Contractor. No settlement for which Participant or Contractor would be responsible shall be made without Participant's or Contractor's consent unless required by final decree of a court of competent jurisdiction.*

OPTION 3: States and State Agencies

When the CRADA involves a State, a State Agency, a State college or university, or a political subdivision of a State or an agency thereof, and such entity is limited by law from assuming all such indemnification obligations, the product liability article may begin with:

> *To the extent permitted by {name of State} State Law and except for any liability resulting from any negligent acts or omissions...*

As an alternative to these examples, a "hold harmless" or "disclaimer" may also be used.

When any of these provisions under Option 3 are incorporated into a CRADA, product liability indemnification by third parties must be provided using the following Option 4, appropriately modified to reflect the correct parties in interest.

OPTION 4: ADDITIONAL CLAUSE: Indemnification by Third Party

When the Contractor retains rights to license or otherwise transfer technology arising under a CRADA, the Contractor may agree to flow down to its licensees or transferees indemnification of the Participant from product liability, such as with the following additional clause:

> *For licenses granted or assignments made by Contractor to any third party in Intellectual Property derived from Generated Information, such licenses shall include the requirement that the third party shall indemnify the Government, Contractor, and Participant for all damages, costs and expenses, including attorneys' fees, arising from personal injury or property damage occurring as a result of the making, using or selling of a product, process or service by or on behalf of such third party, its assignees or licensees, provided, however, such third parties shall not be required to indemnify the Participant for any negligent or intentional acts or omissions of the Participant.*

OPTION 5: Purchase Of Product Liability Insurance

The Participant or the Contractor may agree to purchase and maintain adequate product liability insurance to protect the Government and the Contractor against product liability claims, such as with the following provision:

> *The ___ (Participant, Contractor, or Parties) agree to obtain and maintain product liability insurance in the amount of $________ during the life of this agreement and subsequently for the life of any products, processes or services resulting from work under the agreement. The Government and the Contractor shall be covered against any claims for product liability as a result of this insurance. A copy of this product liability insurance policy shall be provided to both the Government and the Contractor, including any material modifications thereto, including any notices of termination.*

The cost for this insurance shall not be charged directly or indirectly to the Government.

OPTION 6: Participant Defends

Except for any liability resulting from any willful misconduct or negligent acts or omissions of Contractor, PARTICIPANT agrees to indemnify the Government and defend Contractor against any claim or proceeding and pay all damages, costs and expenses, including attorney's fees, arising from personal injury or property damage occurring as a result of the making, using or selling of a product, process or service by or on behalf of the PARTICIPANT, its assignees or licensees, which was derived from the work performed under this CRADA. In respect to this article, neither the Government nor Contractor shall be considered assignees or licensees of the PARTICIPANT. The agreement set forth in this paragraph shall apply only if PARTICIPANT shall have been informed as soon and as completely as practical by Contractor and/or the Government of the action alleging such claim and shall have been given an opportunity, to the maximum extent afforded by applicable laws, rules or regulations, to participate in and control its defense, and Contractor and/or the Government shall have provided all reasonable assistance requested by PARTICIPANT. No settlement of an action against the Contractor and/or Government for which PARTICIPANT would be responsible hereunder shall be made without the consent of the PARTICIPANT and of the Contractor and the Government (whichever or both of the latter two parties is involved), unless required by final decree of a court of competent jurisdiction.

GENERAL GUIDANCE:

If the results of the research covered by the CRADA are restricted in any way for the purpose of commercialization (such as through patents, copyrights, or Protected CRADA Information), or if there is a specific, identifiable laboratory technology being transferred, there must be a provision that indemnifies the Contractor and the Government from all costs related to personal injury and property damage that may result from the Participant's commercialization and utilization of a product, process or service. The protection should usually take the form of the above DOE sample CRADA provision on product liability.

Special situations may provide for the deletion of the language of the above product liability provision from the CRADA or may justify the use of some other provision in its place. Examples of special situations where a product liability provision is not required to be included in a CRADA are:

(a) Where it is determined that the results will be a product, process or service unlikely to be commercialized (e.g., activity is limited to technical assistance); circumstances must be such that they justify the exclusion of the product liability indemnity provision from the agreement. Such determinations will be made on a case-by-case basis and will be supported by facts indicating there is little or no potential risk of liability to the Government or the Contractor. The authority to make these determinations shall reside with the laboratory director.

(b) Where the results are to be placed totally in the public domain (i.e., no Protected CRADA Information or Intellectual Property) and accompanied by a DOE approved disclaimer; if the purpose of the agreement is to provide information which is intended to be placed in the public domain with an appropriate disclaimer provision, then the use of a product liability provision need not be used.

(c) When the GOCO has agreed to accept the risk for product liability without indemnification by the Government (Option 2 above); in order for this acceptance to be effective, the acceptance must be in writing and signed by an authorized official of the Contractor. This acceptance should be reviewed for legal sufficiency to insure that it does not directly or indirectly require indemnification by the Government should liability be found.

In the event any of the above paragraphs (a) to (c) apply, this Article should be [Reserved].

ARTICLE VII: OBLIGATIONS AS TO PROPRIETARY INFORMATION

LANGUAGE:

A. *If Proprietary Information is orally disclosed to a Party, it shall be identified as such, orally, at the time of disclosure and confirmed in a written summary thereof, appropriately marked by the disclosing party, within ____ (_) days as being Proprietary Information.*

OPTION

A. *Proprietary Information may be disclosed orally, electronically, visually or in a written or other intangible form. To the extent that any Generated Information divulges, duplicates or substantially duplicates Proprietary Information, such Generated Information shall be marked and treated as Proprietary Information, if identified as such, orally, at the time of disclosure and confirmed in a written summary thereof within 30 days as being Proprietary Information.*

GUIDANCE: Alternative language which may be used if desired.

B. *Each Party agrees to not disclose Proprietary Information provided by another Party to anyone other than the CRADA Participant and Contractor without written approval of the providing Party, except to Government employees who are subject to the statutory provisions against disclosure of confidential information set forth in the Trade Secrets Act (18 USC 1905).*

(based on a DOE policy that its employees not sign non-disclosure agreements, based on the provisions of the above-cited criminal statute)

OPTION

B. *Each Party agrees not to disclose Proprietary Information provided by another Party to anyone other than the CRADA Participant and Contractor without written approval of the providing Party, except to Government employees who are subject to 18 USC 1905.*

Disclosures of Proprietary Information to DOE employees shall occur only onsite at the Contractor's facilities unless mutually agreed upon by the Parties. Contractor and DOE shall limit their respective internal disclosure of Proprietary Information to those employees or agents having a need to know such information.

GUIDANCE: Alternative language which may be used if desired.

C. *All Proprietary Information shall be returned to the provider thereof at the conclusion of this CRADA at the provider's expense.*

OPTION

C. *Proprietary Information in tangible form shall be returned to the disclosing Party or destroyed with a certificate of destruction submitted to the disclosing party upon request by the disclosing Party during the term of the CRADA or upon termination or expiration of this CRADA, unless otherwise approved in writing by the disclosing Party*

GUIDANCE: Alternative language which may be used if desired.

D. All Proprietary Information shall be protected for a period of _____ years, unless and until such Proprietary Information shall become publicly known without the fault of the recipient, shall come into recipient's possession without breach of any of the obligations set forth herein by the recipient, or shall be independently developed by recipient's employees who did not have access to such Proprietary Information.

OPTION:

D. All information marked as Proprietary Information shall be protected by the recipient as Proprietary Information for a period of _____ years, unless and until, as shown by the recipient, such Proprietary Information shall become publicly known without the fault of the recipient, shall come into recipient's possession from a third party without an obligation of confidentiality on the recipient, shall be independently developed by recipient's employees who did not have access to such Proprietary Information, is intentionally released by the disclosing Party to a third party without restriction, or is released for disclosure with the written consent of the disclosing Party.

GUIDANCE: May be used as an alternative to Paragraph D, if desired.

The following paragraph may be included in this article if desired.

E. In no case shall the Contractor provide Proprietary Information of Participant to any person or entity for commercial purposes, unless otherwise agreed to in writing by such Participant.

GENERAL GUIDANCE:

If Proprietary Information will be involved in the CRADA, then a definition along the lines of the Freedom of Information Act (5 USC 552) and Stevenson-Wydler statute (15 USC 3710 a(c)(7)(A)) must be included in Article I: Definitions, of the CRADA, clearly indicating that Proprietary Information is "information embodying trade secrets developed outside the CRADA at private expense." The Contractor cannot negotiate away the right of a government employee subject to 18 USC 1905 to see CRADA-related Proprietary Information. The Contractor should seek additional rights to

Proprietary Information at the DOE laboratory where program needs require rights greater than those prescribed in the DOE sample CRADA clauses (i.e., including limiting the period in which Proprietary Information is maintained as proprietary when such information is retained by the Contractor).

The obligations of the Parties with regard to Proprietary Information should require that all such materials be sufficiently identified and marked such that the personnel involved in the project will have no trouble in understanding what materials are to be protected. The Parties should stipulate whether the Contractor will return such materials, destroy them, or keep them at the end of the work on the CRADA. If information could not be protected as a valid trade secret, or commercial or financial information, then it should not be protected under the CRADA.

If the Parties will be using software, biological materials, specimen materials, equipment or other tangible personal property which a Party wants ~~to~~ protect as proprietary, then such items should be included in the definition of Proprietary Information to assure such protection. Additional materials can be found at 48 CFR 927.400.

Parties may wish to return Proprietary Information before the conclusion of the CRADA where such information is no longer needed for CRADA work.

ARTICLE VIII: OBLIGATIONS AS TO PROTECTED CRADA INFORMATION

LANGUAGE:

A. *Each Party may designate as Protected CRADA Information, as defined in Article I, any Generated Information produced by its employees and, with the agreement of the other Party, designate any Generated Information produced by the other Party's employees. All such designated Protected CRADA Information shall be appropriately marked.*

B. *For a period of _____ [not to exceed five years] from the date Protected CRADA Information is produced, Parties agree not to further disclose such Information except:*

(1) *as necessary to perform this CRADA;*

(2) *as provided in Article XI* [REPORTS AND ABSTRACTS]*;*

(3) *as requested by the DOE Contracting Officer to be provided to other DOE facilities for use only at those DOE facilities with the same protection in place;*

(4) *to existing or potential licensees, affiliates, customers or suppliers of the Parties in support of commercialization of the technology with the same protection in place. Disclosure of Participant's Protected CRADA Information under this subparagraph shall only be done with Participant's consent; or*

(5) *as mutually agreed by the Parties in advance.*

(by DOE policy:

(1) Ensures that anticipated DOE mission benefit is received from CRADAs;

(2) avoids duplication of expense and effort;

(3) helps to advance technology; and

(4) enables DOE to meet statutory requirements to disseminate information after the expiration of the withholding period)

OPTION 1

B. For a period of _____ [not to exceed five years] from the date Protected CRADA Information is produced, pursuant to 15 USC 3710 a(c)(7)(B), Parties agree not to further disclose such Information and to use the same degree of care and discretion, but no less than reasonable care and discretion, to avoid disclosure, publication or dissemination of such Information to a third party, as the Party employs for similar protection of its own information which it does not desire to disclose, publish or disseminate except:

1. as necessary to perform this CRADA;

2. as provided in Article XI [Reports and Abstracts];

3. *as requested by the DOE Contracting Officer to be provided to other DOE facilities solely for Government use only at those DOE facilities with the same protection in place;*

4. *to existing or potential licensees, affiliates, customers, or suppliers of the Parties in support of commercialization of the technology with the same protection in place. Disclosure of Participant's Protected CRADA Information under this subparagraph shall only be done with Participant's consent.; or*

5. *as mutually agreed by the Parties in advance.*

GUIDANCE: Alternative language which may be used if desired.

OPTION 2

B. For a period of _____ [not to exceed five years] from the date Protected CRADA Information is produced, pursuant to 15 USC 3710 a(c)(7)(B), Parties agree not to further disclose such Information and to use the same degree of care and discretion, but no less than reasonable care and discretion, to avoid disclosure, publication or dissemination of such Information to a third party, as the Party employs for similar protection of its own information which it does not desire to disclose, publish or disseminate except:

1. as necessary to perform this CRADA;

2. as provided in Article XI; [REPORTS AND ABSTRACTS];

3. *other than as provided in Article XI, as requested by the DOE Contracting Officer to be provided to other DOE facilities for use only at those facilities with the same protection in place;*

4. *to existing or potential licensees, affiliates, customers, or suppliers of the Parties in support of commercialization of the technology with the same protection in place. Disclosure of Participant's Protected CRADA Information under this subparagraph shall only be done with Participant's consent; or*

5. *as mutually agreed by the Parties in advance.*

GUIDANCE: Alternative language which may be used if desired.

C. The obligations of (B) above shall end sooner for any Protected CRADA Information which shall become publicly known without fault of either Party, shall come into a Party's possession without breach by that Party of the obligations of (B) above, or shall be independently developed by a Party's employees who did not have access to the Protected CRADA Information.

OPTION

C. The obligations of paragraph B above shall end sooner for any Protected CRADA Information which shall become publicly known without fault of either Party, shall be independently developed outside of the CRADA by a Party's employees who did not have access to the Protected CRADA Information, or is disclosed through product released by Participant. If recipient receives any information independently developed by a third party without any obligation of confidentiality which is similar to Protected CRADA Information, disclosure by recipient of such third party information shall not be a breach of this CRADA.

GUIDANCE: Alternative language, which may be used if desired.

GENERAL GUIDANCE:

If the Parties desire, provisions for Protected CRADA Information can also be included with the normal marking requirements and exceptions. The Contractor cannot negotiate away DOE's right to share Protected CRADA Information with other DOE facilities having the same protection in place without the approval of the DOE Operations Office or Field Office responsible for the CRADA. The DOE Sample CRADA's Article VIII B. or comparable language must be included in the CRADA.

The Parties should negotiate the respective responsibilities for marking Generated Information that meets the definition of Protected CRADA Information and the obligations that will attach to such information. The Parties shall embody the rights and obligations in an appropriate legend. The DOE Modular CRADA language allows each Party to mark its own Generated Information and someone else's Generated Information with their agreement. The Parties should address the issue of further dissemination of Protected CRADA Information within the DOE community. The wording of the definition for Protected CRADA Information should be along the lines of the Stevenson-Wydler statute (15 USC 3710a(c)(7)(B)) and placed in the Definitions article to support the substantive clause on protecting this material. The CRADA must include a requirement that designated Protected CRADA Information be appropriately marked.

Generated Information that is marked Protected CRADA Information cannot be protected for more than five (5) years. The Parties should negotiate the term for which it will be protected and the nature of the obligations of the Parties with regard to such Protected CRADA Information. If no protection is needed or when protection is no longer permitted, the Parties should resolve to quickly publish the Generated Information.

ARTICLE IX: RIGHTS IN GENERATED INFORMATION

LANGUAGE:

The Parties agree that they shall have no obligations of non-disclosure or limitations on their use of, and the Government shall have unlimited rights in, all Generated Information, all Protected CRADA Information after the expiration of the period set forth in Article VIII (B) above and information provided to the Government or Contractor under this CRADA which is not marked as being copyrighted (subject to Article XIII) or as Protected CRADA Information (subject to Article VIII B) or Proprietary Information (subject to Article VII B), or which is an invention disclosure which may later be the subject of a U.S. or foreign patent application.

OPTION

The Government shall have unlimited rights in all Generated Information produced or provided by the Parties under this CRADA, except for information which is disclosed in a Subject Invention disclosure being considered for patent protection, protected as a mask work right, or marked as being copyrighted, Protected CRADA Information, or Proprietary Information.

GUIDANCE: Alternative language which may be used if desired.

GENERAL GUIDANCE:

There should be a provision recognizing the Government's unlimited rights in Generated Information, except as otherwise restricted.

ARTICLE X: EXPORT CONTROL

LANGUAGE:

A. *THE PARTIES UNDERSTAND THAT MATERIALS AND INFORMATION RESULTING FROM THE PERFORMANCE OF THIS CRADA MAY BE SUBJECT TO EXPORT CONTROL LAWS AND THAT EACH PARTY IS RESPONSIBLE FOR ITS OWN COMPLIANCE WITH SUCH LAWS.*

OPTION FOR FOREIGN PARTICIPANTS

A. *THE PARTIES UNDERSTAND THAT MATERIALS AND INFORMATION RESULTING FROM THE PERFORMANCE OF THIS CRADA MAY BE SUBJECT TO U.S. EXPORT CONTROL LAWS AND THAT EACH PARTY IS RESPONSIBLE FOR ITS OWN COMPLIANCE WITH SUCH LAWS.*

The following approved language was developed to address foreign ownership, control, or influence issues with respect to the Partner. It should only be used for those Cooperative Research and Development Agreements involving access to classified information, access to special nuclear materials, or unescorted access to security areas of Departmental facilities. If it is not used, then there is only one paragraph, pertaining to export control, and the designator "A," may be deleted.

B. *The Participant has a continuing obligation to provide the Contractor written notice of any changes in the nature and extent of foreign ownership, control, or influence over the Participant which would affect the Participant's answers to the previously completed FOCI certification.*

GENERAL GUIDANCE:

There must be an export control warning statement to warn the Parties that material and information resulting from the CRADA may be export controlled. This statement should be conspicuous, like the UCC-like disclaimer.

If the Cooperative Research and Development Agreement involves access to classified information, access to special nuclear materials, or unescorted access to security areas of Departmental facilities, the requirements of the Atomic Energy Act of 1954, as amended, must be met, this article of the Cooperative Research and Development Agreement should be retitled EXPORT CONTROL / FOREIGN OWNERSHIP AND CONTROL, and there should be language added pertaining to FOCI. The completed FOCI questionnaire attached as Appendix A must be completed by the Participant and included as Appendix A to the CRADA.

ARTICLE XI: REPORTS AND ABSTRACTS

LANGUAGE:

A. *The Parties agree to produce the following deliverables:*

   (1) *an initial abstract suitable for public release at the time the CRADA is approved by DOE;*

   (2) *other abstracts (final when work is complete, and others as substantial changes in scope and dollars occur);*

   (3) *a final report, upon completion or termination of this CRADA, to include a list of subject inventions;*

   (4) *a semi-annual signed financial report of the Participant's in-kind contributions to the project;*

   (5) *other topical/periodic reports where the nature of research and magnitude of dollars justify; and*

   (6) *computer software in source and executable object code format as defined within the Statement of Work or elsewhere within the CRADA documentation.*

B. *It is understood that the Contractor has the responsibility to provide the above information at the time of its completion to the DOE Office of Scientific and Technical Information.*

C. *Participant agrees to provide the above information to the Contractor to enable full compliance with paragraph B. of this Article.*

(DOE has a responsibility to disseminate scientific and technical information, by 42 USC 2051(d), 42 USC 2161(b) and 42 USC 2166(b).)

D. *It is understood that the Contractor and the Department of Energy have a need to document the long-term economic benefit of the cooperative research being done under this agreement. Therefore, the Participant acknowledges a responsibility to respond to reasonable requests, during the term of this CRADA and for a period of _____ years* [two to five years would be reasonable] *thereafter from the Contractor for pertinent information.*

Guidance

There is currently no requirement that the Participant must respond to information requests made by the Department through the Contractor regarding long-term economic data (i.e., the results of commercializing products, processes or services based on this CRADA), but the Participant should recognize that the Department has a need to measure economic outcomes of CRADAs that it funds. Such follow-up surveys are already being done for R&D 100 award winning technologies without intruding into sensitive market, or financial information. Measurement of the outcomes of cooperative research, both for the Department and for the Participant, is a very important aspect of the Department's Technology Partnerships activity. Examples of the types of long term economic data that could be sought include jobs created/lost/retained, increases in market share, and sales increases. Surveys would be done in such a way that answers are provided in broad categories (i.e., 1-50 jobs created, etc.) in a "check-the-box" approach. Mechanisms used to gather the information could include customer surveys, third party personal interviews and third party studies commissioned by the Department.

GENERAL GUIDANCE:

There must be a provision setting forth deliverables that are required for each CRADA. The Contractor should ensure that, at a minimum, abstracts, a final report and other topic/periodic reports (where appropriate) are specified to be furnished to DOE for each CRADA. The abstracts should not contain any Proprietary Information. An abstract suitable for public release which is not protectable must be furnished to DOE, as part of the initial reporting of the CRADA process, for inclusion in DOE's Integrated Technology Transfer System (ITTS). Further, where the Participant and/or the Contractor identifies that such reports furnished contain Protected CRADA Information, the reports will be properly marked with a restrictive legend identifying the agreed-to period of withholding from public disclosure; such reports shall be furnished to the DOE Office of Scientific and Technical Information for Departmental use only and be withholdable for the stated withholding period as materials exempt from Subchapter II of Chapter 5 of Title 5, United States Code. The Contractor must assure that adequate deliverables are provided to OSTI to assure that the results of DOE-approved CRADAs are made known to other DOE contractors for DOE program needs.

Alternative language may be developed in other instances, such as a CRADA involving technical assistance, where the type of work to be performed does not lead to the documentation required by the language of this article.

The Contracting Officer will direct the Contractor as to which deliverables will be furnished to OSTI. This will include, as a minimum, (1) an initial abstract suitable for public release, (2) a final report, and (3) all generated software in object code format as defined within the Statement of Work. It is expected that the initial abstract will be delivered with the CRADA when it is submitted to DOE for approval.

The submission of a semi-annual signed financial report of the Participant's in-kind contributions to the project will both provide assurance that the Participant is providing in-kind contributions in accordance with the CRADA and will also serve to indicate the validity and reasonableness of the Participant's valuation of its in-kind contributions.

The Scope of Work should be written so that the agreed-upon deliverables are included in it.

CRADA reports should fully cover and describe the research done under the CRADA incorporating technical data as needed to support conclusions, and including Protected CRADA Information as appropriate. The appropriate OSTI report form (DOE 1332.15) is included as Appendix _____.

It is recognized that cooperative research performed in CRADAs involves industrial partners that have information which they consider to be of commercial value. Such commercially valuable information could possibly be divulged in the formal CRADA document, including the incorporated Statement of Work. Due to the use of taxpayer funds in the Government share of CRADAs, it is possible that there will be requests for public release of the formal CRADA document. Commercially valuable information that the partner considers sensitive should not routinely be included in the CRADA, including the accompanying Statement of Work, unless specifically needed. Should DOE receive a request for public release of the formal CRADA document, only business-sensitive or proprietary information that qualifies under 5 USC 552(b)(4) will be exempt from release after appropriate review.

If no computer software is to be developed under this CRADA, then subparagraph A(6) may be [reserved].

ARTICLE XII: PRE-PUBLICATION REVIEW

LANGUAGE:

A. *The Parties agree to secure pre-publication approval from each other which shall not be unreasonably withheld or denied beyond ___days.*

OPTION

A. *The Parties anticipate that their employees may wish to publish technical developments and/or research findings generated in the course of this CRADA. On the other hand, the Parties recognize that an objective of this CRADA is to provide business advantages to Participant. In order to reconcile publication and business concerns, the Parties agree to a review procedure as follows:*

1. *Each Party ("Submitter") shall submit to the other Party ("Recipient"), in advance, proposed written and oral publications pertaining to work under the CRADA. Proposed oral publications shall be submitted to Recipient in the form of a written presentation synopsis and a written abstract.*

2. *Recipient shall provide a written response to the Submitter within thirty (30) days, either objecting or not objecting to the proposed publication. Submitter shall consider all objections of Recipient and shall not unreasonably refuse to incorporate the suggestions and meet the objections of Recipient. The proposed publication shall be deemed not objectionable, unless the proposed publication contains Proprietary Information, Protected CRADA Information, or material that would create potential statutory bars to filing the United States or corresponding foreign patent applications, in which case express written permission shall be required for publication.*

GUIDANCE: Alternative language ,intended only to provide greater detail on procedures to be followed, which may be used if desired.

B. *The Parties agree that neither will use the name of the other Party or its employees in any promotional activity, such as advertisements, with reference to any product or service resulting from this CRADA, without prior written approval of the other Party.*

GENERAL GUIDANCE:

A publication review provision must be included. A clause is included in the DOE Sample CRADA. The pre-publication review process must consider the protection of rights to filing U.S. and foreign patent applications, since any disclosure may be a bar to filing.

ARTICLE XIII: COPYRIGHTS

LANGUAGE:

A. *The Parties may assert copyright in any of their Generated Information.* Assertion of copyright generally means to enforce or give any indication of ar intent or right to enforce such as by marking or securing Federal registration.

B. *[Allocation of rights to Copyrights in Generated Information will be negotiated by the Parties.]*

OPTION

B. *All Participant and Contractor copyrights to original information for which authorship takes place during the performance of work under this CRADA shall be owned and licensed as set forth in Appendix ___ (if any) subject to any obligation of protection as required in Articles VII and VIII and other provisions of this Article.*

GUIDANCE: Alternative language which may be used if desired.

C. *For Generated Information, the Parties acknowledge that the Government has for itself and others acting on its behalf, a royalty-free, non-transferable, non-exclusive, irrevocable worldwide copyright license to reproduce, prepare derivative works, distribute copies to the public, and perform publicly and display publicly, by or on behalf of the Government, all copyrightable works produced in the performance of this CRADA, subject to the restrictions this CRADA places on publication of Proprietary Information and Protected CRADA Information.*

(DOE has a responsibility to disseminate scientific and technical information, by 42 USC 2051(d), 42 USC 2161(b) and 42 USC 2166(b).)

D. *For all copyrighted computer software produced in the performance of this CRADA, the Party owning the copyright will provide the source code, an expanded abstract as described in Appendix C, the executable object code and the minimum support documentation needed by a competent user to understand and use the software to DOE's Energy Science and Technology Software Center, P.O. Box 1020, Oak Ridge, TN 37831.*

The expanded abstract will be treated in the same manner as Generated Information in paragraph C of this Article.

E. The Contractor and the Participant agree that, with respect to any copyrighted computer software produced in the performance of this CRADA, DOE has the right, at the end of the period set forth in paragraph B of Article VIII hereof and at the end of each two-year interval thereafter, to request the Contractor and the Participant and any assignee or exclusive licensee of the copyrighted software to grant a non-exclusive, partially exclusive, or exclusive license to a responsible applicant upon terms that are reasonable under the circumstances, provided such grant does not cause a termination of any licensee's right to use the copyrighted computer software. If the Contractor or the Participant or any assignee or exclusive licensee refuses such request, the Contractor and the Participant agree that DOE has the right to grant the license if DOE determines that the Contractor, the Participant, assignee, or licensee has not made a satisfactory demonstration that it is actively pursuing commercialization of the copyrighted computer software.

Before requiring licensing under this paragraph E, DOE shall furnish the Contractor/Participant written notice of its intentions to require the Contractor/Participant to grant the stated license, and the Contractor/Participant shall be allowed 30 days (or such longer period as may be authorized by the cognizant DOE Contracting Officer for good cause shown in writing by the Contractor/Participant) after such notice to show cause why the license should not be required to be granted.

The Contractor/Participant shall have the right to appeal the decision by the DOE to the grant of the stated license to the Invention Licensing Appeal Board as set forth in paragraphs (b)-(g) of 10 CFR 781.65, "Appeals".

F. The Parties agree to place Copyright and other notices, as appropriate for the protection of Copyright, in human readable form onto all physical media, and in digitally encoded form in the header of machine readable information recorded on such media such that the notice will appear in human readable form when the digital data are off loaded or the data are accessed for display or printout.

OPTION 1:

G. For computer programs agreed by Participant and Contractor as being developed principally for commercialization by the Participant and listed in Appendix ___ or a modification to this Appendix pursuant to Article XXIX, the Party owning the copyright will provide an expanded abstract as described in Appendix C to DOE's Energy Science and Technology Software Center (ESTSC). Source code developed solely by Participant shall be owned and retained by Participant and shall not be subject to delivery to Contractor or Government. Source code developed solely by Contractor, or jointly developed by Contractor and Participant, shall be first offered to Participant through an exclusive or non-exclusive license, at Participant's choice, under fair, reasonable, and appropriate terms as set forth in Appendix ___. For all computer programs covered by this paragraph, the object code and the minimum support documentation needed by a competent user to understand and use the software ("Usage Package") will be delivered to Contractor to use for non-commercial purposes and will be provided to ESTSC for licensing only to other DOE contractors (with Participant named as a third party beneficiary under such license for enforcement of the restricted use provisions) for only non-commercial use solely under their contracts with DOE in accordance with this Article and Appendix ___ and under the Disclaimer provisions of Article V. Participant shall make available to ESTSC, at its request, any maintenance releases of the Usage Package created by Participant for a period of two years after the development of the Usage Package. It is understood that this includes both repairs of defects as well as substantive improvements to the Usage Package. The Contractor and the Participant agree that the Government has for itself and others acting on its behalf a royalty-free, non-transferable, non-exclusive, irrevocable worldwide license to reproduce, and perform publicly and display publicly, by or on behalf of the Government for non-commercial purposes, the Usage Package, including the above-recited repairs of defects and substantive improvements, subject to the restrictions this CRADA places on publication of Proprietary Information and Protected CRADA Information and subject to the further restriction that neither the Government nor its contractors may decompile or reverse assemble the object code.

GUIDANCE: This option may be used when the CRADA, from the Participant's perspective, is aimed at the creation of software for commercialization. Since, with this Paragraph, the Government has agreed not to receive the source code for specifically identified items of software for its use and that of its Contractors, there must be a specific determination by the funding program office that receipt as a deliverable under the CRADA of only an executable object code for its use and that of its contractors would not have a negative impact on accomplishment of the program mission.

OPTION 2:

G. *Notwithstanding Paragraph D. of this Article, for computer programs identified by the Participant and the Contractor where receipt of the source code is not deemed vital to securing DOE mission benefits from the CRADA, the party owning the Copyright will provide an executable object code, an expanded abstract as described in Appendix C, and a user manual sufficient for a competent user to use and understand the software to DOE's Energy Science and Technology Software Center, P.O. Box 1020, Oak Ridge, Tennessee 37831. The expanded abstract will be treated in the same manner as Generated Information* in Paragraph C. of this Article.

Guidance:

These two G. options should be used when the purpose of the CRADA is to create software where receipt of the source code is not deemed vital to securing DOE mission benefits from the CRADA. There must be another mission benefit from the CRADA if the source code is not to be delivered. Since, with this Paragraph, the Government has agreed not to receive the source code for its use and that of its Contractors, a specific determination is required by the funding program office that providing as a deliverable under the CRADA only an executable object code for this use and that of its contractors would not have a negative impact on accomplishment of the program mission.

GENERAL GUIDANCE:

DOE, by approving a CRADA, authorizes the Participant and the Contractor to assert copyright in Generated Information. The Parties must grant to the U.S. an irrevocable, paid-up copyright license to any and all works that come out of the project and may be copyrightable. The Parties may also make this or any other negotiated license reciprocal among themselves. As an alternative, the Parties can agree as part of the CRADA to negotiate the software license rights each Party is to receive upon the production and copyright of software under the CRADA. The Contractor must assure that all copyrighted works are available to other DOE Contractors for Governmental purposes.

Copies of all generated computer software on which copyright protection will be asserted must be delivered to the Energy Science and Technology Software Center (ESTSC) by either (1) delivering same directly to ESTSC or (2) delivering same to the Contractor, who will in turn deliver it to ESTSC. The delivery to the DOE Energy Science and Technology Software Center (ESTSC) of materials with respect to copyrighted computer software may be done by having the Participant deliver the materials to the Contractor who will in turn deliver them to the ESTSC. The Contractor may delay the applicability of the DOE march-in rights of paragraph E for up to five years from the date that the software is produced. The Participant should be given a right of appeal to DOE's march-in right.

Jointly developed copyrighted material should be addressed. One way is to specify that any copyrights in Generated Information jointly attributable to Contractor and Participant employees should be jointly owned by the Contractor and the Participant.

The Parties should also be careful to appropriately mark, as Protected CRADA Information, in human readable form onto all physical media and in digitally encoded form in all machine-readable information.

A suggested format for the expanded Abstract called for in Article XIII is attached as Appendix C.

If no copyrights are contemplated to be created under a CRADA, then this Article may be [reserved].

ARTICLE XIV: REPORTING SUBJECT INVENTIONS

LANGUAGE:

A. *The Parties agree to disclose to each other each and every Subject Invention, which may be patentable or otherwise protectable under the Patent Act. The Parties acknowledge that the Contractor and Participant will disclose their respective Subject Inventions to the DOE within two (2) months after the inventor first discloses the Subject Invention in writing to the person(s) responsible for patent matters of the disclosing Party.*

OPTION

A. *The Parties agree to disclose to each other through the Project Managers each and every Subject Invention which may be patentable or otherwise protectable under the Patent Act within two (2) months, or such longer period as is reasonably required, after the inventor first discloses the Subject Invention in writing to the person(s) responsible for patent matters of the disclosing Party. The Contractor and Participant will disclose such Subject Inventions to the DOE, the Contractor doing so in accordance with its prime contract.*

GUIDANCE: Alternative language which may be used if desired. If it is, then the alternate Article on Project Management should be used, as well, in order to provide a definition and list of duties for Project Managers.

B. *These disclosures should be in sufficiently complete technical detail to convey a clear understanding, to the extent known at the time of the disclosure, of the nature, purpose and operation of the Subject Invention The disclosure shall also identify any known actual or potential statutory bars, i.e., printed publications describing the Subject Invention or the public use or on sale of the Subject Invention in this country. The Parties further agree to disclose to each other any subsequent known actual or potential statutory bar that occurs for a Subject Invention disclosed but for which a patent application has not been filed. All Subject Invention disclosures shall be marked as confidential under 35 USC 205.*

OPTION 1

B. These disclosures should be in sufficiently complete technical detail to convey a clear understanding to the extent known at the time of the disclosure of the nature, purpose, and operation of the Subject Invention and shall also identify any events that could give rise to a statutory bar (i.e., printed publications describing the Subject Invention or the public use or "on sale" of the Subject Invention in this country). The Parties further agree to disclose to each other any subsequently known statutory bar that occurs for a Subject Invention disclosed but for which a patent application has not been filed. All Subject Invention disclosures shall be marked as confidential under 35 USC 205.

GUIDANCE: Alternative language which may be used if desired.

OPTION 2

B. *These disclosures should be in sufficiently complete technical detail to convey a clear understanding to the extent known at the time of the disclosure of the nature, purpose and operation of the Subject Invention. The disclosure shall also identify any statutory bars, i.e., printed publications describing the Subject Invention or the public use or "on sale" of the Subject Invention in this country. The Parties further agree to disclose to each other any subsequent statutory bar that occurs for a Subject Invention disclosed but for which a patent application has not been filed. All Subject Invention disclosures shall be marked as confidential under 35 USC 205.*

GUIDANCE: Alternative language which may be used if desired.

GENERAL GUIDANCE:

There must be an article which states that the Parties agree to promptly disclose to each other and to the DOE all Subject Inventions made under the CRADA. Disclosures should be written so as to serve as a basis for patent applications. Since any public disclosure can be a bar to U.S. and some foreign filings, the Parties may wish to state that the disclosure should identify any publication describing the invention, public use or sale of the invention.

ARTICLE XV: TITLE TO SUBJECT INVENTIONS

LANGUAGE:

Whereas the Participant and the Contractor have been granted the right to elect to retain title to Subject Inventions,

A. *[Allocation of rights will be negotiated by the Parties.]*

Some alternative options which may be used for subparagraph XV.A are:

Option 1

A. *Each Party shall have the first option to elect to retain title to any Subject Invention made by its employees and said election shall be made: (1) for the Participant within 12 months of disclosure of the Subject Invention to DOE or (2) for the Contractor within the time period specified in its prime contract for electing to retain title to Subject Inventions. If a Party elects not to retain title to any Subject Invention of its employees, then the other Party shall have the second option to elect to retain title to such Subject Invention in accordance with Appendix [if used] of this CRADA. The DOE shall retain title to any Subject Invention which is not retained by any Party.*

Guidance: Extensions under this option may be granted for good and sufficient cause. Non-profit Contractors may change "shall retain" to "may retain" in the third from last line of this Paragraph.

Option 2

A. *The Parties intend that title to any Subject Inventions of either Party shall be owned by ____________, and the Parties agree to make the necessary elections and assignments to effect this intent (subject to any DOE approvals, if necessary).*

Option 3

A. *For Subject Inventions conceived or first actually reduced to practice under this CRADA which are joint Subject Inventions made by the Contractor and the Participant, title to such Subject Inventions shall be jointly owned by the Contractor and the Participant.*

(This may be used in conjunction with a statement that each Party has title to Subject Inventions produced exclusively by that Party.)

Option 4

Where it is appropriate to have a cross-licensing provision, Paragraph XV.A can be amended to include the following statement:

A. *Each Party grants each other Party a non-exclusive, transferable, irrevocable, paid-up license to practice or to have practiced for or on behalf of that Party every invention arising out of this Agreement throughout the world, with a right to grant sublicenses of no greater scope to others.*

B *The Parties acknowledge that the DOE may obtain title to each Subject Invention reported under Article XIV for which a patent application or applications are not filed pursuant to Article XVI and for which any issued patents are not maintained by any Party to this CRADA.*

(by 35 USC 202(c)(2) for DOE's non-profit M&O Contractors entering into CRADAs and a matter of DOE policy for other M&O Contractors and CRADA Participants.)

C. *The Parties acknowledge that the Government retains a non-exclusive, non-transferable, irrevocable, paid-up license to practice or to have practiced for or on behalf of the United States every Subject Invention under this CRADA throughout the world.*

(by 15 USC 3710a (b)(2)&(3), as well as 35 USC 202(c)(4))

GENERAL GUIDANCE:

There must be an article which sets forth the allocation of rights to Subject Inventions between the Parties. The same article must say that DOE retains rights for Subject Inventions for which a Party to the CRADA does not file for or maintain patents. The same article must also say that the Government retains a non-exclusive, non-transferable, irrevocable, paid-up license to practice or to have practiced for or on behalf of the United States every Subject Invention under this CRADA throughout the world. It should be noted that exceptional circumstances under 35 USC 202(a) may provide a different disposition of rights than is set forth in this article.

ARTICLE XVI: FILING PATENT APPLICATIONS

LANGUAGE:

A. *The Parties agree that the Party initially indicated as having an ownership interest in any Subject Inventions (Inventing Party) shall have the first opportunity to file U.S. and foreign patent applications. If the Participant does not file such applications within one year after election, or if the Contractor does not file such applications within the filing time specified in its prime contract, then the other Party to this CRADA exercising an option pursuant to Article XV may file patent applications on such Subject Inventions. If a patent application is filed by the other party (Filing Party), the Inventing Party shall reasonably cooperate and assist the Filing Party, at the Filing Party's expense, in executing a written assignment of the Subject Invention to the Filing Party and in otherwise perfecting the patent application, and the Filing Party shall have the right to control the prosecution of the patent application. The Parties shall agree between themselves as to who will file patent applications on any joint Subject Invention.*

GUIDANCE: The Parties may also wish to set forth who files for patents on which inventions, including the treatment of joint inventions. If extensions of time are necessary, on a case-by-case basis, such extensions can be obtained consistent with Article XXIX. Other terms for filing foreign applications can be negotiated when appropriate.

OPTION

A. *The Parties agree that the Party initially indicated as having an ownership interest in any Subject Inventions shall have the first opportunity to file U.S. and foreign patent applications; but if such Party does not file such applications within one year after disclosure, then the other Party to this CRADA may file patent applications on such Subject Inventions. If a patent application is filed by the other Party ("Filing Party"), the Inventing Party shall reasonably cooperate and assist the Filing Party, at the Filing Party's expense, in executing a written assignment of the Subject Invention to the Filing Party and in otherwise perfecting the patent application, and the Filing Party shall have the right to control the prosecution of the patent application. The Parties shall agree among themselves as to who will file patent applications on any joint Subject Invention.*

GUIDANCE: Alternative language which may be used if desired.

B. *The Parties agree that DOE has the right to file patent applications in any country if neither Party desires to file a patent application for any Subject Invention. Notification of such negative intent shall be made in writing to the DOE Contracting Officer within three (3) months of the decision of the non-inventing party to not file a patent application for the Subject Invention pursuant to Article XV or not later than 60 days prior to the time when any statutory bar might foreclose filing of a U.S. patent application.*

Three additional paragraphs have been approved for use in this Article if desired:

C. *A Party electing title or filing a patent application in the United States or in any foreign country shall advise the other Party and the DOE if it no longer desires to continue prosecution, pay maintenance fees, or retain title in the United States or any foreign country. The other Party and then the DOE will be* *afforded the opportunity to take title and retain the patent rights in the United States or in any such foreign country.*

D. Each Party agrees to provide the Project Manager of the other Party with a copy of each patent application it files on any Subject Invention.

GUIDANCE

This Paragraph D. can be used in any event, but if it is used, it will be necessary to include the additional Article providing a definition and list of duties of the Project Manager.

E. Every ____ months from the date of the CRADA, each Party shall deliver to the other Party interim reports listing the Subject Inventions, if any, it has produced during the preceding ____-month period. If a Party has produced no Subject Invention for any ____-month period, the Party's interim report for that period will explicitly state so.

GENERAL GUIDANCE

There must be an article by which the Parties agree that if neither Party desires to file a patent application for any invention, notice of such negative intent shall be made to the DOE within nine months after the initial disclosure of such invention or not later than 60 days prior to the time when any statutory bar might foreclose filing of a U.S. patent application.

ARTICLE XVII: TRADEMARKS

If no Trademarks are contemplated to be created under this CRADA, then this Article may be [reserved]. If Trademarks are contemplated to be created under this CRADA, the following language may be used for this Article:

LANGUAGE:

> *The Parties may seek to obtain Trademark/Service Mark protection on products or services generated under this agreement in the United States or foreign countries. [The ownership and other rights relating to this Trademark shall be as mutually agreed to in writing by the Parties.] The Parties hereby acknowledge that the Government shall have the right to indicate on any similar goods or services produced by or for the Government that such goods or services were derived from and are a DOE version of the goods or services protected by such Trademark/Service Mark with the Trademark and the owner thereof being specifically identified. In addition, the Government shall have the right to use such Trademark/Service Mark in print or communications media.*

OPTION

The following sentence may be added to the end of the above language, if desired:

> *Where the Government indicates on goods that such goods were derived from goods protected by a Trademark/Service Mark, the Government will also indicate that the Trademark owner has had no right to perform a quality review/inspection of the DOE version of the goods.*

GUIDANCE: One CRADA Participant objected to the Government's retention of any right to use any Trademark owned by the Participant because the Participant had no right to perform a quality review or inspection of the DOE version of the Trademarked goods. The above addition to the language is offered as a possible response to such an objection.

GENERAL GUIDANCE:

By approving a CRADA, DOE authorizes the Contractor and the Participant to assert Trademark protection for products or services arising out of the performance of that CRADA. The Parties shall acknowledge the Government's right to indicate the relationship between the goods and services it produces and those protected by Trademark/Servicemark in appropriate circumstances. The Parties may negotiate between themselves any licensing rights they desire, consistent with the Government's license.

Trademarks for jointly developed products or services should be addressed in the CRADA. One way is to specify that any Trademarks in generated products or services jointly attributable to Contractor and Participant employees shall be jointly owned by the Contractor and the Participant.

ARTICLE XVIII: MASK WORKS

If no Mask Works are contemplated to be created under this CRADA, then this Article may be [reserved]. If Mask Works are contemplated to be created under this CRADA, the following language may be used for this Article:

LANGUAGE:

> *The Parties may seek to obtain legal protection for Mask Works fixed in semiconductor products generated under this agreement as provided by Chapter 9 of Title 17 of the United States Code. [The rights to any Mask Work covered by this provision shall be as mutually agreed to in writing by the Parties.] The Parties hereby acknowledge that the Government or others acting on its behalf shall retain a non-exclusive, paid-up, worldwide, irrevocable, non-transferable license to reproduce, import, or distribute the covered semiconductor product by or on behalf of the Government, and to reproduce and use the Mask Work by or on behalf of the Government.*

GENERAL GUIDANCE:

By approving a CRADA, DOE authorizes the Contractor and the Participant to assert mask work protection for semiconductor chip products first produced during the performance of that CRADA The Parties shall grant to the Government and others acting on its behalf an irrevocable, paid-up license to use any of these covered products. The Parties may negotiate between themselves any licensing rights they desire, consistent with the Government's license.

Jointly developed semiconductor chip materials may be registered for protection and this should be addressed in the CRADA. One way is to specify that any mask works fixed in semiconductor chip products generated under the CRADA and jointly attributable to Contractor and Participant employees shall be jointly owned by the Contractor and the Participant.

ARTICLE XIX: COST OF INTELLECTUAL PROPERTY PROTECTION

LANGUAGE:

Each Party shall be responsible for payment of all costs relating to Copyright, Trademark and Mask Work filing, U.S. and foreign patent application filing and prosecution, and all costs relating to maintenance fees for U.S. and foreign patents hereunder which are solely owned by that Party. Government/DOE laboratory funds contributed as DOE's cost share to a CRADA cannot be given to Participant for payment of Participant's costs of filing and maintaining patents or filing for Copyrights, Trademarks and Mask Works.

OPTION

Each Party shall be responsible for payment of all costs relating to copyright filing, U.S. and foreign patent application filing and prosecution, and all costs relating to maintenance fees for U.S. and foreign patents hereunder which are owned by that Party.

GUIDANCE: For use when Trademark and Mask Work articles are omitted.

GENERAL GUIDANCE:

There must be an article which sets out the Parties' agreement on the costs of filing for and maintaining patents as well as the costs of filing for copyrights, Trademarks and mask works, where applicable. This article should include consideration of any jointly-owned intellectual property.

ARTICLE XX: REPORTS OF INTELLECTUAL PROPERTY USE

LANGUAGE:

Participant agrees to submit, for a period of _____years and upon request of DOE, a non-proprietary report no more frequently than annually on efforts to utilize any Intellectual Property arising under the CRADA.

GENERAL GUIDANCE:

There must be an article by which the Parties set out their agreement with regard to reporting efforts to obtain utilization of Intellectual Property arising under the CRADA. This is needed so that DOE can document the linkage of the CRADA to DOE mission benefits as well as to customer satisfaction and other performance measurement aspects of the CRADA program. As is indicated by the term limit, it is clearly intended that this Participant obligation will survive completion or termination of the CRADA.

ARTICLE XXI: DOE MARCH-IN RIGHTS

LANGUAGE:

> *The Parties acknowledge that the DOE has certain march-in rights to any Subject Inventions in accordance with 48 CFR 27.304-1(g).*
>
> (by 35 USC 203 for M&O Contractors; by DOE policy for CRADA Participants:
>
> (1) Provides for consistent treatment of CRADA Participants;
>
> (2) Helps promote commercialization of technology from CRADAs; and
>
> (3) Protects the interest of taxpayers.)

GENERAL GUIDANCE:

There must be an article which says that the Parties recognize that the DOE has certain march-in rights to any inventions arising from the performance of this CRADA in accordance with 48 CFR 27.304-1(g).

ARTICLE XXII: U.S. COMPETITIVENESS

LANGUAGE:

The Parties agree that a purpose of this CRADA is to provide substantial benefit to the U.S. economy.

In exchange for the benefits received under this CRADA, the Participant therefore agrees to the following:

A. *Products embodying Intellectual Property developed under this CRADA shall be substantially manufactured in the United States;*

B. *Processes, services, and improvements thereof which are covered by Intellectual Property developed under this CRADA shall be incorporated into the Participant's manufacturing facilities in the United States either prior to or simultaneously with implementation outside the United States. Such processes, services, and improvements, when implemented outside the U.S., shall not result in reduction of the use of the same processes, services, or improvements in the United States; and*

OPTION:

A plan for providing net benefit to the U.S. economy is attached in Appendix _____.

GUIDANCE:

In the event that the Participant is unable or unwilling, in advance, to meet the requirements of Article XXII.A. and XXII.B. above, this language will be substituted for those two Paragraphs.

C. *The Contractor agrees to a U.S. Industrial Competitiveness clause in accordance with its prime contract with respect to any licensing and assignments of its intellectual property arising from this CRADA, except that any licensing or assignment of its intellectual property rights to the Participant shall be in accordance with the terms of Paragraphs A. and B. of this Article.*

GENERAL GUIDANCE:

There must be an Article which sets forth the Parties' agreement with respect to benefits to accrue to the U.S. economy as a result of the CRADA. The preferred benefit is that any products for use or sale in the U.S. under any intellectual property that may issue resulting from an invention which arises from the performance of the CRADA shall be manufactured substantially in the U.S. Contractors shall ensure that adequate benefits are being secured for the U.S. taxpayer for the commercialization world-wide of intellectual property arising under the CRADA. Commitment to alternative benefits as part of or in conjunction with this Article or another Article of the CRADA (i.e. Article II) are acceptable in certain situations, and are provided for in this guidance.

The Government, in funding CRADAs, is seeking to transfer technology to companies with significant manufacturing and research facilities in the United States in a way which will provide short and long term benefits to the U.S. economy and the industrial competitiveness of such companies.

The Department's policy on U.S. competitiveness is based on the fact that billions of taxpayer dollars have paid for the research at DOE laboratories. Before technology is transferred from DOE laboratories, we as negotiator/agents are required to ensure that the taxpayers (who also pay our salaries) will receive some return on their investment. The preferred benefit to the U.S. economy is the creation and maintenance of manufacturing capabilities and jobs within the U.S. However, if a potential partner cannot identify increased U.S. jobs as a result of the technology being transferred, some other substantial economic benefit to the U.S. economy must be identified. DOE policy on U.S. competitiveness is stated in the memorandum of February 10, 1993 issued by the Director of Technology Utilization. It is:

- It is DOE policy for the laboratories, in their selection of CRADA partners, to give preference to business units located in the United States which agree to substantially manufacture resulting technology in the U.S.
- DOE will approve, as exceptions, agreements with some partners on the basis of contractual commitments to appropriate alternative benefits to the U.S. economy Exceptions must be based on specific information and not generic assertions;
- In situations where there are multiple partnering opportunities in a common technical or technology area, and limitations on resources for partnering, preference should be given to partnerships that accept the requirement for substantial U.S. manufacturing;
- The U.S. competitiveness aspects of prospective CRADA partners and CRADAs will be resolved as up-front matters, before completion of any Joint Work

Statements. Where Joint Work Statements are forwarded to Program Offices, they will be preceded by either written assurances that the Participant intends to accept the sample CRADA U.S. competitiveness language in toto or else a signed agreement in which the Participant agrees to provide specific economic benefit to the U.S. economy under one or more criteria of the U.S. competitiveness work sheet. This signed agreement must set forth specific detailed measures. Departure from U.S. competitiveness commitments made by CRADA partners can be a basis for stopping work under the CRADA and will be considered as background information in any future CRADA negotiation with the same CRADA partner. It should also be emphasized to prospective CRADA partners that, once they give these U.S. competitiveness related assurances to DOE, their departure from them in subsequent stages of the CRADA negotiation will result in prolonged negotiations and could be taken as evidence of negotiating in bad faith; and

- In instances where the Operations Office or Field Office is unable or unwilling to make a determination as to whether U.S. competitiveness requirements have been satisfied, they should refer the matter to the appropriate Program Office for a determination. The Program Office may then consult with the Office of Technology Utilization and may also choose to seek the advice of the Technology Transfer Committee.
- DOE, in its policy on U.S. competitiveness, distinguishes among products, which are manufactured, and processes and services, which are practiced or implemented. In the context of a multi-national firm, it may be advantageous to the U.S. economy and to the competitive position of the firm for a process or service to be implemented worldwide as quickly as possible.

The work sheet attached as "Appendix B" contains criteria for Operations Office or Field Office and Program Office use in deciding whether U.S. competitiveness requirements have been satisfied, should it be necessary to use the above option.

ARTICLE XXIII: ASSIGNMENT OF PERSONNEL

LANGUAGE:

A. *It is contemplated that each Party may assign personnel to the other Party's facility as part of this CRADA to participate in or observe the research to be performed under this CRADA. Such personnel assigned by the assigning Party shall not during the period of such assignments be considered employees of the receiving Party for any purposes.*

OPTION

A. *It is contemplated that each Party may assign personnel to the other Party's facility as part of this CRADA. Such personnel assigned by the assigning Party to participate in or observe the research to be performed under this CRADA shall not during the period of such assignments be considered employees of the receiving Party for any purposes, including but not limited to any requirements to provide workers' compensation, liability insurance coverage, payment of salary or other benefits, or withholding of taxes.*

GUIDANCE: Alternative language which may be used for Paragraph A, if desired, and providing more complete recitation of exclusions.

B. *The receiving Party shall have the right to exercise routine administrative and technical supervisory control of the occupational activities of such personnel during the assignment period and shall have the right to approve the assignment of such personnel and/or to later request their removal by the assigning Party.*

OPTION

B. The assigning Party's employees and agents shall observe the working hours, security and safety rules, and holiday schedule of the receiving Party while working on the receiving Party's premises. Receiving Party shall have the reasonable right to approve the assignment of personnel or request their removal by the assigning Party.

GUIDANCE: Alternative language which may be used if desired.

C. The assigning Party shall bear any and all costs and expenses with regard to its personnel assigned to the receiving Party's facilities under this CRADA. The receiving Party shall bear facility costs of such assignments.

OPTION

C. The assigning Party shall bear any and all costs and expenses with regard to its personnel assigned to the receiving Party's facilities under this CRADA. The receiving Party shall bear the costs of providing an appropriate work space, access to a telephone, use of laboratory, manufacturing or other work areas as appropriate, and any other utilities and facilities related to such assignments.

GUIDANCE: Alternative language for Paragraph C which may be used, if desired, and provides more complete and explicit recitation of facilities, et al, to be provided by the receiving Party to assigned personnel.

GENERAL GUIDANCE:

If it is contemplated that personnel may be assigned back and forth between the facilities, then a provision for such an assignment must be included in the CRADA so that such assignments of personnel can be easily facilitated during the course of the CRADA.

Contractors should ensure that, when this Article is being discussed, Participants are given copies of Contractor regulations, procedures, policies and practices for entrance of outside personnel to work in the laboratories and/or facilities, especially where foreign Participants are involved.

ARTICLE XXIV: FORCE MAJEURE

LANGUAGE:

> *No failure or omission by Contractor or Participant in the performance of any obligation under this CRADA shall be deemed a breach of this CRADA or create any liability if the same shall arise from any cause or causes beyond the control of Contractor or Participant, including but not limited to the following, which, for the purpose of this CRADA, shall be regarded as beyond the control of the Party in question: Acts of God, acts or omissions of any government or agency thereof, compliance with requirements, rules, regulations, or orders of any governmental authority or any office, department, agency, or instrumentality thereof, fire, storm, flood, earthquake, accident, acts of the public enemy, war, rebellion, insurrection, riot, sabotage, invasion, quarantine, restriction, transportation embargoes, or failures or delays in transportation.*

GENERAL GUIDANCE:

A force majeure clause stating that neither Party will be liable for unforeseeable events beyond its reasonable control must be included in the CRADA. The article may be expanded beyond that contained in the sample.

ARTICLE XXV: ADMINISTRATION OF THE CRADA

LANGUAGE:

It is understood and agreed that this CRADA is entered into by the Contractor under the authority of its prime Contract with DOE. The Contractor is authorized to and will administer this CRADA in all respects unless otherwise specifically provided for herein. Administration of this CRADA may be transferred from the Contractor to DOE or its designee with notice of such transfer to the Participant, and the Contractor shall have no further responsibilities except for the confidentiality, use and/or non-disclosure obligations of this CRADA.

OPTION

It is understood and agreed that this CRADA is entered into by the Contractor under the authority of its prime Contract with DOE. The Contractor is authorized to and will administer this CRADA in all respects unless otherwise specifically provided for herein. Administration of this CRADA may be transferred from the Contractor to DOE or its designee as a successor to Contractor who is assuming responsibilities for the facilities managed by Contractor with notice of such transfer to the Participant, and the Contractor shall have no further responsibilities except for the confidentiality, use and/or non-disclosure obligations of this CRADA. This CRADA shall be binding upon and inure to the benefit of the Parties, and their respective successors and assigns.

GUIDANCE: Alternative language which may be used if desired.

GENERAL GUIDANCE:

There must be an administration of CRADA article which says that the CRADA is entered into by the Contractor under the authority of its prime contract with DOE. The Article must also allow DOE to substitute another Contractor (with notice to the Participant) in the event that there is a change of Contractors at the facility.

ARTICLE XXVI: RECORDS AND ACCOUNTING FOR GOVERNMENT PROPERTY

LANGUAGE:

> *The Participant shall maintain records of receipts, expenditures, and the disposition of all Government property in its custody related to the CRADA.*

OPTION

> *The Participant shall maintain records of the following with respect to all Government property in its custody, related to the CRADA: receipts, expenditures, and dispositions. Participant represents that its accounting system is in accordance with generally accepted accounting principles.*

GUIDANCE: Alternative language which may be used if desired.

GENERAL GUIDANCE:

There must be a records and accounting system provision for the CRADA, requiring the Participant to maintain records of receipts, expenditures, and the disposition of all Government property in its custody.

Where Government property will be under the Participant's control, Contractors should include language regarding periodic access, inspection, inventory and records of the property. In such a case, the Contractor may choose to add the following language:

> *The Participant shall, with reasonable notice, grant to the Government and to the Contractor periodic access to Participant's premises during regular business hours for the purposes of inspection of CRADA-related Government property in its custody.*

ARTICLE XXVII: NOTICES

LANGUAGE:

A. *Any communications required by this CRADA, if given by postage prepaid first class U.S. Mail or other verifiable means addressed to the Party to receive the communication, shall be deemed made as of the day of receipt of such communication by the addressee, or on the date given if by verified facsimile. Address changes shall be given in accordance with this Article and shall be effective thereafter. All such communications, to be considered effective, shall include the number of this CRADA.*

B. *The addresses, telephone numbers and facsimile numbers for the Parties are as follows:*

OPTION

B. *The addresses, telephone numbers and facsimile numbers for the Parties are as follows:*

1. For CONTRACTOR:

U.S. Mail Only: *FedEx, UPS, Freight*

________________ ________________
________________ ________________
________________ ________________
________________ ________________
________________ ________________

a. FORMAL NOTICES AND COMMUNICATIONS, COPIES OF REPORTS

Attn: ____________________
Tel: ____________________
Fax: ____________________

b. PROJECT MANAGER, REPORTS, COPIES OF FORMAL NOTICES AND COMMUNICATIONS

Attn: ____________________
Tel: ____________________
Fax: ____________________

2. For PARTICIPANT:
U.S. Mail Only: *FedEx, UPS, Freight*

________________ ________________
________________ ________________
________________ ________________

a. FORMAL NOTICES AND COMMUNICATIONS, COPIES OF REPORTS
Attn: ____________________
Tel: ____________________
Fax: ____________________

b. PROJECT MANAGER, REPORTS, COPIES OF FORMAL NOTICES AND COMMUNICATIONS
Attn: ____________________
Tel: ____________________
Fax: ____________________

GUIDANCE: Alternative language, which may be used if desired.

GENERAL GUIDANCE:

There should be a provision for communications among the Parties to the CRADA for invoicing and receipt of funds, as well as other notices under the CRADA.

ARTICLE XXVIII: DISPUTES

LANGUAGE:

The Parties shall attempt to jointly resolve all disputes arising from this CRADA. If the Parties are unable to jointly resolve a dispute within a reasonable period of time, they agree to [Process to be negotiated by the Parties]. To the extent that there is no applicable U.S. Federal law, this CRADA and performance thereunder shall be governed by the law of the State of ________.

OPTION 1:

The Parties shall attempt to jointly resolve all disputes arising from this CRADA. If the Parties are unable to jointly resolve the dispute within a reasonable period of time, they agree to follow the dispute resolution process set forth in Appendix ___. To the extent that there is no applicable U.S. Federal law, this CRADA and performance thereunder shall be governed by the law of the state of ____________________, without reference to that state's conflict of laws provisions.

GUIDANCE: Alternative language which may be used if desired.

Option 2:

The Parties shall attempt to jointly resolve all disputes arising from this CRADA. If the Parties are unable to jointly resolve a dispute within a reasonable period of time, the dispute shall be decided by the DOE Contracting Officer, who shall reduce his/her decision to writing within 60 days of receiving in writing the request for a decision by either Party to this CRADA. The DOE Contracting Officer shall mail or otherwise furnish a copy of the decision to the Parties. The decision of the DOE Contracting Officer is final unless, within 120 days, the Participant brings an action for adjudication in a court of competent jurisdiction in the State of _______________. To the extent that there is no applicable U.S. Federal law, this CRADA and performance thereunder shall be governed by the law of the State of _______________.

GUIDANCE: Alternative language, which may be used if desired.

Option 3

At the request of either Party, after reasonable attempt to settle without arbitration, any controversy or claim arising out of or relating to the CRADA shall be settled by arbitration conducted in the State of - ____________ in accordance with the then current and applicable rules of the American Arbitration Association. Judgment upon the award rendered by the Arbitrator(s) shall be non-binding on the Parties.

Guidance: Alternative language, which may be used if desired.

General Guidance:

There must be a dispute resolution article which requires the Parties to attempt to settle disputes themselves (with or without the assistance of third parties) before taking them to court. If the Parties are unable to jointly resolve a dispute within a reasonable period of time, they may agree to seek mediation, non-binding arbitration, use the good offices of the DOE Contracting Officer and/or seek adjudication in a court of competent jurisdiction. It is strongly recommended that the Contractor seek to include an intermediate step after it attempts to directly resolve the dispute with the Participant before going to court.

ARTICLE XXIX: ENTIRE CRADA AND MODIFICATIONS

LANGUAGE:

A. *It is expressly understood and agreed that this CRADA with its Appendices contains the entire agreement between the Parties with respect to the subject matter hereof and that all prior representations or agreements relating hereto have been merged into this document and are thus superseded in totality by this CRADA. This CRADA shall not be effective until approved by DOE.*

B. *Any agreement to materially change any terms or conditions of this CRADA or the Appendices shall be valid only if the change is made in writing, executed by the Parties hereto, and approved by DOE. (by 15 USC 3710a(c)(5)(C)(iv))*

OPTION 1

The last sentence of Paragraph A may be modified to read:

This CRADA shall not be effective until approved by DOE and the effective date shall be the date when signed by the last of the Parties.

GUIDANCE: Alternative language which may be used if desired.

OPTION 2

A. *It is expressly understood and agreed that this CRADA with its Appendices, which are attached hereto and incorporated herein by reference, contains the entire agreement between the Parties with respect to the subject matter hereof and that all prior representations or agreements relating hereto have been merged into this document and are thus superseded in totality by this CRADA. This CRADA shall not be effective until approved by DOE.*

GUIDANCE: Alternative language which may be used if desired.

GENERAL GUIDANCE:

There must be an article stating that all the terms and conditions of the CRADA are entirely contained within the CRADA agreement and its Appendices (for example, Statement of Work). Subsequent modifications to the CRADA must acknowledge or supersede this statement.

ARTICLE XXX: TERMINATION

LANGUAGE:

This CRADA may be terminated by either Party upon ___days written notice to the other Party. This CRADA may also be terminated by the Contractor in the event of failure by the Participant to provide the necessary advance funding, as agreed in Article III.

In the event of termination by either Party, each Party shall be responsible for its share of the costs incurred through the effective date of termination, as well as its share of the costs incurred after the effective date of termination, and which are related to the termination. The confidentiality, use, and/or non-disclosure obligations of this CRADA shall survive any termination of this CRADA.

FOR CONTRACTOR:

*BY*___________________________________

*TITLE*________________________________

*DATE*________________________________

FOR PARTICIPANT:

*BY*___________________________________

*TITLE*________________________________

*DATE*________________________________

OPTION 1:

This CRADA may be terminated by either Party upon 30 days written notice to the other Party. In the event of termination by either Party, each Party shall be responsible for its share of the costs incurred through the effective date of termination, as well as its share of the costs incurred after the effective date of termination, and which are related to the termination. The confidentiality, use and/or non-disclosure rights and obligations of this CRADA shall survive any termination of this CRADA.

GUIDANCE: Alternative language which may be used if desired.

OPTION 2:

If desired, Article XXX may be expanded to include the effective date of the CRADA and the period of performance by alteration of the title of Article XXX and inclusion of the following paragraph:

> *The effective date of this CRADA shall be the latter date of (1) the date on which it is signed by the last of the Parties hereto or (2) the date on which it is approved by DOE. The work to be performed under this CRADA shall be completed within ____ months/years from the effective date.*

GUIDANCE: Some Contractors and Participants may wish to specify the effective date and expiration date of the CRADA and this language is offered as a means to that end.

GENERAL GUIDANCE:

There should be a termination clause. In addition to any other obligations which are created at termination of the CRADA, it is intended that any confidentiality obligations of the CRADA shall survive. Intellectual Property provisions should also survive, where applicable. Contractors may add other, more explicit language to this article if they can obtain agreement from Participants. The termination clause may also reference Article III: Funding and Costs in so far as to clearly state that "failure of the Participant to provide the necessary advance funding, or to promptly pay the invoices rendered by the Contractor is cause for termination of the CRADA."

ARTICLE ___. PROJECT MANAGEMENT

A. *Each Party shall assign and identify in writing a Project Manager prior to the start of the CRADA. Either Party may change its Project Manager by providing written notification to the other. Each Project Manager shall be responsible for coordinating all matters relating to this CRADA, any Statement of Work hereunder, and all other related matters between the Parties. All communications between the Parties relating to this CRADA shall take place between the Project Managers.*

B. *Project Managers for this CRADA are as follows:*

for CONTRACTOR	*for PARTICIPANT*
____________________	____________________
____________________	____________________
____________________	____________________

C. *The Parties will use reasonable efforts to manage the disclosure of Proprietary Information or Protected CRADA Information through the Project Managers or their designees; however, failure to do so will not cause any marked Proprietary Information or any marked Protected CRADA Information to lose the protection afforded by Articles VII and VIII.*

General Guidance:

This additional article has been approved for use if desired. The same or similar information may also be provided under Article XXVII B, in which case the title of that Article should be "Notices and Project Management."

These additional articles have been approved for use if desired:

Article ____: Order of Precedence

In the event of a conflict between the provisions of the Appendices and those of this Agreement, this Agreement shall prevail.

Article ____: Waiver

The failure of Contractor or Participant at any time to enforce any provisions of this Agreement or to exercise any right or remedy shall not be construed to be a waiver of such provisions or of such right or remedy or of the right of Contractor or Participant thereafter to enforce each and every provision, right or remedy.

Appendix A:

FOCI QUESTIONNAIRE FOR APPLICABLE COOPERATIVE RESEARCH AND DEVELOPMENT AGREEMENTS

(To be used by proposed participants in technology transfer agreements involving participant access to classified information or special nuclear materials or unescorted access to security areas of Departmental facilities. This information is requested in accordance with provisions of the Atomic Energy Act of 1954, as amended)

Instructions:

I. For the purposes of this questionnaire, a foreign interest is defined as any of the following:

A. A foreign government or foreign government agency;
B. Any form of business enterprise organized under the laws of any country other than the United States or its possessions;
C. Any form of business enterprise organized or incorporated under the laws of the U. S., or a State or other jurisdiction within the U. S., which is owned, controlled, or influenced by a foreign government, agency, firm, corporation or person; or
D. Any person who is not a U. S. citizen.

II. If your organization has not previously submitted responses to the following questions, then provide the information requested herein. Answer each question in either the yes or no space. If the answer to any of the questions is yes, provide the detailed information requested in the attached Guidelines for Completing the FOCI Certification for that specific question. Information which responds to these questions and which has been previously submitted to a Government agency may be resubmitted for this questionnaire if the information is accurate, complete, and current.

III. If you own other entities, you must provide consolidated information for all your wholly- and majority-owned subsidiaries (foreign and domestic). If you are owned by a parent organization, it must also complete a FOCI certification which should be submitted along with your certification.

IV. Each FOCI representation must also include the following supporting information:

A. Identification of all your organization's owners, officers, directors and executive personnel, including their names; social security numbers; citizenship; titles of all positions they hold within your organization; and clearances they possess, if any, and the name of the agency(ies) which granted the clearances.

B. Your organization's latest annual report and the Securities and Exchange Commission Form 10-K. If you are a privately-held company or a subsidiary of another corporation and cannot provide these documents, the appropriate official within your organization (e.g., chief financial officer, treasurer, or secretary) must provide the following consolidated financial information for all wholly- and majority-owned subsidiaries and affiliates: assets, current and total; liabilities, current and total; stockholders equity; revenue and net income; and, the amount of revenue derived from foreign interests.

V. The certification of the FOCI questionnaire must be signed by an individual who can legally do so for the participant and may include an owner, officer, or director.

QUESTIONS:

1. Does a foreign interest own or have beneficial ownership in 5% of more of your organization's voting securities?

_____ Yes _____ No

2. Does your organization own 10% or more of any foreign interest?

_____ Yes _____ No

3. Do any foreign interests have management positions such as directors, officers, or executive personnel in your organization?

_____ Yes _____ No

4. Does any foreign interest control or influence, or is any foreign interest in a position to control or influence the election, appointment, or tenure of any of your directors, officers, or executive personnel?

_____ Yes _____ No

5. Does your organization have any contracts, binding agreements, understandings, or arrangements with a foreign interest(s) that cumulatively represent 10% or more of your organization's gross income?

_____ Yes _____ No

6. Is your organization indebted to foreign interests?

_____ Yes _____ No

7. Does your organization derive any income from sensitive countries included on the attached list?

_____ Yes _____ No

8. Is 5% or more of any class of your organization's securities held in ``Nominee shares,'' in ``street names'', or in some other method which does not disclose beneficial ownership of equitable title?

_____ Yes _____ No

Does your organization have interlocking directors with reign interests?

_____ Yes   _____ No

. Are there any citizens of foreign countries employed by, or o may visit, your offices or facilities in a capacity which y permit them to have access to classified information or a significant quantity of special nuclear material?

_____ Yes   _____ No

. Does your organization have foreign involvement not otherwise covered in your answers to the above questions?

_____ Yes   _____ No

CERTIFICATION:

Check one:

( ) I certify that the entries made herein are accurate, complete, and current to the best of my knowledge and belief, and are made in good faith.

( ) I certify that the information requested herein has been previously submitted to the Department of Energy as required for a facility clearance, and that the information in the previous submission is accurate, complete, and current for the purposes of this Cooperative Research and Development Agreement.

CERTIFIED BY:

____________________: NAME OF PARTNER REPRESENTATIVE

____________________: TITLE

____________________: STREET ADDRESS

____________________: CITY STATE, ZIP CODE

____________________: SIGNATURE AND DATE

Appendix A (Continued):

GUIDELINES FOR COMPLETING
FOREIGN OWNERSHIP, CONTROL, OR INFLUENCE CERTIFICATION

Question Number 1. Does a foreign interest own or have beneficial ownership in 5% of more of your organization's voting securities?

Identify the percentage of any class of shares or other securities issued which are owned by foreign interests, listed by country. If you answered "Yes" and have received from an investor a copy of Schedule 13D or Schedule 13G filed by the investor with the Securities and Exchange Commission, you are to attach a copy of Schedule 13D or Schedule 13G.

Question Number 2. Does your organization own 10% or more of any foreign interest?

If your answer is "Yes", furnish the name of the foreign interest, address by country, and the percentage owned. For each employee occupying a position with the foreign firm, provide the following information:

1. Complete name.
2. Citizenship.
3. Titles of positions within the foreign entity.
4. Clearances, if any, they possess, and by whom those clearances were granted.
5. To what extent the employees are involved in the operations of the foreign facilities.
6. Whether or not any of these individuals will, by virtue of their position, knowledge, or expertise, require access to Department of Energy classified information.

If the employees possess Department of Energy clearances, or are in the process of being cleared, and hold positions with foreign interests, they need to complete the attached "Representative of Foreign Interest Statement" for each such firm.

Does your organization have branch or sales offices or other facilities, or are you qualified to do business as a foreign corporation in any other countries? If the answer is "Yes", list all.

What percentage of your organization's gross income is derived from your foreign subsidiaries or affiliates?

Question Number 3. Do any foreign interests have management positions such as directors, officers, or executive personnel in your organization?

Furnish details concerning the identity of the foreign interest and the position(s) held in your organization, to include the amount of time the individual spends at your facility. If the individual spends less than full time at your facility, provide information on how and where the rest of his/her time is spent.

Question Number 4. Does any foreign interest control or influence, or is any foreign interest in a position to control or influence the election, appointment, or tenure of any of your directors, officers, or executive personnel?

Identify the foreign interest(s) and furnish details concerning the control or influence. If the individuals have been excluded from access to Department of Energy classified information by Board resolution or corporate exclusion, an official (signed and dated) copy of such exclusion must be submitted with this package.

Question Number 5. Does your organization have any contracts, binding agreements, understandings, or arrangements with a foreign interest(s) that cumulatively represent 10% or more of your organization's gross income?

Furnish the name of the foreign interest, country, and nature of agreement or involvement. If there is no ownership involved in these arrangements, provide details along the same lines of information required for Question Number 2. Certification should be made as to whether or not the agreements are:

1. Purely commercial in nature.
2. Involve defense procurement
3. Involve classified information.
4. Involve sensitive countries.

Provide the amount of revenue derived from foreign sources. This should be provided by country. Also, state the time frame, e.g., fiscal year ending December 31, 1992, during which the revenue was derived. This should include revenue from all foreign sources, e.g., subsidiaries, equity income derived from your interest in less than wholly-owned subsidiaries, export sales, divestitures to foreign interests, royalties from licensing and patent agreements, dividends from foreign stock holdings, and investment or real estate. Compliance with export license requirements and international traffic in arms regulations (ITAR) requirements must be acknowledged, if applicable.

In addition, due to the political sensitivity of some countries, the Department of Energy requires that you provide the following information if you derive revenue and have other understandings or arrangements with sensitive countries:

1. The amount of international and export revenue.
2. The type of service or product provided (be specific - show whether they are commercial in nature or involve defense procurement).
3. Compliance with export license and ITAR requirements, if applicable.
4. Any other involvement not covered by the prior two elements of this question.

NOTE: Information provided must be audited information, and NOT MORE THAN ONE YEAR OLD.

Question Number 6. Is your organization indebted to foreign interests?

Report all lines of credit your organization has with foreign interests even if there is no current indebtedness. Provide the following information:

1. The amount and type of indebtedness.
2. If any debentures are convertible, explain under what circumstances.
3. The name(s) of the lending institution(s) and the country (ies) in which they are located.
4. What collateral, if any, has been furnished or pledged.
5. The total line of credit available from these lending institutions.
6. What percentage of your current assets does this indebtedness represent?
7. If you have a worldwide line of credit available, what is the total line of credit available from foreign sources?

NOTE: If you own other entities, you must provide consolidated information for all of your wholly- and majority-owned subsidiaries (foreign and domestic).

GENERAL GUIDANCE

The Department of Energy Operations Offices or Field Offices are required to include a foreign ownership, control, or influence (FOCI) review as part of their security review of Cooperative Research and Development Agreements involving Participant access to classified information, access to special nuclear materials[1], or unescorted access to security areas within Departmental facilities. If a Cooperative Research and Development Agreement does not involve access to classified information, special nuclear materials, or secure facilities, a FOCI review is not required to meet the Department's national security obligations as mandated by the Atomic Energy Act of 1954, as amended[2]

In those cases requiring a FOCI review, it is required that the prospective partner's response to the eleven FOCI questions, including required additional information and the certification, be received by the Department of Energy prior to approval of the associated Joint Work Statement. These materials should be submitted as early as possible to the normal Joint Work Statement/Cooperative Research and Development Agreement contact at the Department of Energy, for referral to the Safeguards and Security point of contact so that the FOCI review process may be initiated expeditiously. If a proposed Joint Work Statement is received by the operations office prior to submission of the needed responses to the FOCI questions, or a proposed Cooperative Research and Development Agreement is received prior to completion of the FOCI review and resolution of outstanding issues, the operations office must decide whether to return the Joint Work Statement or Cooperative Research and Development Agreement for further information or to disapprove it[3].

In general, no Cooperative Research and Development Agreement involving access to classified information, access to special nuclear materials, or unescorted access to security areas of

---

[1] For the purposes of these guidelines, special nuclear materials shall mean quantities as defined in 10 CFR Part 710.

[2] If an individual has the ability and/or opportunity to obtain access to classified information or matter by being in a place where such information or matter is accessible, and, if the security measures which are in force do not prevent the gaining of access to the classified information or matter, then the FOCI review must be completed regardless of whether the Cooperative Research and Development Agreement involves classified matter or information.

[3] The option to return for additional information should not be used instead of a disapproval but only when the operations office does not have sufficient information to make an approval/disapproval decision.

Departmental facilities will be approved until the FOCI review is complete and all FOCI issues are resolved. One option, available at operations office discretion, is to phase the work in such a way that unclassified activities are initiated in an earlier phase than those requiring access to classified information, special nuclear materials, or security areas of Departmental facilities. Approval of unclassified phases of the work could precede the completion of the FOCI determination. Approval of phases of the work involving classified information, special nuclear materials, or unescorted access to security areas of Departmental facilities must await the FOCI determination and resolution of any FOCI issues. The operations office may require additional justification from Management & Operating contractors to address the risk associated with terminating a Cooperative Research and Development Agreement between phases.

Implementation of the FOCI review should be done in a manner which ensures that the statutory deadlines for the Department of Energy's processing of Joint Work Statements and Cooperative Research and Development Agreements are met. Information submitted by the partner as required pursuant to the FOCI review shall be treated by the Management and Operating Contractor and by the Department of Energy, to the extent permitted by law, as business or financial information submitted in confidence to be used solely for purposes of evaluating FOCI[4].

For Cooperative Research and Development Agreements involving access to classified information or special nuclear materials, or unescorted access to security areas of Departmental facilities, the Cooperative Research and Development Agreement must contain provisions which assure that changes in the partner's FOCI status are promptly reported over the term of the agreement. In cases where a partner reports such changes or if more than five years have passed since any previous FOCI determination, the Management and Operating Contractor shall forward that information to the Department of Energy according to its established procedures for FOCI review. Certain changes in the FOCI status of the partner in an approved Cooperative Research and Development Agreement could result in direction from security organizations that access of the partner to classified information, special nuclear materials, or security areas of Departmental facilities be limited. The authority to limit access is inherent in operative Department of Energy orders. If the partner becomes subject to FOCI and cannot, or chooses not to, avoid or mitigate the FOCI problem, and the partner's access to classified information is essential to continuation of the collaborative work, the Management and Operating Contractor shall provide notice of termination according to Article XXX of the Cooperative Research and Development Agreement and expedite the orderly shutdown of collaborative work.

---

[4] Nothing in this guidance relieves the obligation to address other considerations such as export control or U. S. competitiveness issues. Broad concerns about existing U. S. competitiveness policies and procedures should be referred to the chairperson of the Department of Energy Technology Transfer Committee for discussion.

Appendix B:

U. S. COMPETITIVENESS WORK SHEET

(for Use in Resolving Issues of U.S. Competitiveness Regarding
Prospective Technology Transfer Agreements and Partners at DOE Laboratories)

The Government, in funding CRADAs, is seeking to transfer technology to companies with significant manufacturing and research facilities in the United States in a way which will provide short and long term benefits to the U.S. economy and the industrial competitiveness of such companies.

The preferred benefit to the U.S. economy is the creation and maintenance of manufacturing capabilities and jobs within the U. S.

1. Will the Participant(s) agree, as part of the CRADA, to substantially manufacture any products or use any processes or perform any services in the United States incorporating or resulting from inventions, copyrights, mask works or protectable data arising from the CRADA work in which the Participant(s) has some commercial rights? Yes____ No____

2. If no, Participant(s) must furnish a description of specific economic or other benefits to the U.S. economy which are related to the commercial use by Participant(s) of the technology being funded under the CRADA and which are commensurate with the Government's contribution to the proposed work.

3. The above-described agreement and/or description of benefits will be provided by the laboratory to the operations office before submission of the Joint Work Statement by the laboratory to the operations office.

Such benefits may include one or more of the following:

☐ Direct or indirect investment in U.S.-based plant and equipment.

☐ Creation of new and/or higher quality U.S.-based jobs.

☐ Enhancement of the domestic skills base.

☐ Further domestic development of the technology.

☐ Significant reinvestment of profits in the domestic economy.

☐ Positive impact on the U.S. balance of payments in terms of product and service exports as well as foreign licensing royalties and receipts.

☐ Appropriate recognition of U.S. taxpayer support for the technology, e.g., a quid-pro-quo commensurate with the economic benefit that would be domestically derived by the U.S. taxpayer from U.S.-based manufacture.

☐ Cross-licensing, sublicensing, and reassignment provisions in licenses which seek to maximize the benefits to the U.S. taxpayer.

Appendix C:

ABSTRACT FORMAT DESCRIPTION

(Character limit for any one field: 2,000)

(Character limit for all information: 9,000)

Text only; no diagrams or flowcharts

Due to the differences in size and complexity among software packages and the corresponding differences in their respective documentation requirements, a specific form for the required Abstract document has not been provided. Instead, this Abstract Format Description contains a listing of the data elements required for the Abstract and a brief description of each data element. The person assembling the submittal package is expected to create the Abstract document using a text editor. Please note that each of the listed data elements is REQUIRED, and a response for each data element MUST be included in the completed Abstract document.

1. Identification. Provide the following two fields to be used to uniquely identify the software. The software acronym plus the short or KWIC (keywords in context) title will be combined to be used as the identification of the software.

   Software Acronym (limit 20 characters). The name given to the main or major segment of module packaged usually becomes the name of the code package. If an appropriate name is not obvious, invent one which is related to the contents.

   Short or KWIC title (limit 80 characters). This title should tell something of the nature of the code system: calculational method, geometry, or any feature that distinguishes this code package from another. It should be telegraphic in style, with no extraneous descriptors, but more than a string of keywords and phrases. The word "code" (alone) and "program" do not belong in a description of a code "package."

2. Author Name(s) and Affiliations. List author(s) or contributor(s) names followed by the organizational affiliation. If more than one affiliation is applicable, please pair authors with their affiliations.

3. Software Completion Date. List approximate date(s) that the version of the executable module(s), which will be created by the submitted program modules, was first used in an application environment.

4. Brief Description. Briefly describe the purpose of the computer program, state the problem being solved, and summarize the program functions and capabilities. This will be the primary field used for announcement purposes.

5. Method of Solution. Provide a short summary of the mathematical methods, engineering principles, numerical algorithms, and procedures incorporated into the software.

6. Computer(s) for which software is written. List the computer(s), i.e., IBM3033, VAX6220, VAX, IBM PC, on which this submittal package will run.

7. Operating System. Indicate the operating system used, release number, and any deviations or exceptions, i.e., is the operating system "off the shelf" with no modifications, or has the operating system been modified/customized. If modified, note modifications in field 11.

8. Programming Language(s) Used. Indicate the programming language(s) in which the software is written along with the approximate percentage (in parentheses) of each used. For example, FORTRAN IV (95%); Assembler (5%).

9. Software Limitations. Provide a short paragraph on any restrictions implied by storage allocation, such as the maximum number of energy groups and mesh points, as well as those due to approximations used, such as implied argument-range limitations. Also to be used to indicate the maximum number of users, etc. or other limitations.

10. Unique Features of the Software. Highlight the advantages, distinguishing features, or special capabilities which may influence the user to select this package over a number of similar packages.

11. Related and Auxiliary Software. If the software supersedes or is an extension of earlier software, identify the original software here. Identify any programs not considered an integral part of this software but used in conjunction with it (e.g., for preparing input data, plotting results, or coupled through use of external data files). Note similar library software, when known.

12. Other Programming or Operating Information or Restrictions. Indicate file naming conventions used, e.g., (filename).DOC (DOC is a filename extension normally used to indicate a documentation file), additional subroutines, function libraries, installation support software, or any special routines required for operation of this package other than the operating system and programming language requirements listed in other fields. If proprietary software is required, this should also be indicated.

13. Hardware Requirements. List hardware and installation environment requirements necessary for full utilization of the software. Include memory and RAM requirements, in addition to any nonstandard features.

14. Time Requirements. Include any timing requirement estimations, both wall clock and computer clock, necessary for the execution of the package. Give enough detail to enable the potential user to estimate the execution time for a given choice of program parameters (e.g., 5-10 min.).

15. References. List citations of pertinent publications. List (by author, title, report number, bar code or order number if available, and date). References are to be broken down into two groupings:

    (a) Reference documents that are provided with the submittal package.
    (b) Any additional background reference materials generally available.

16. Categorization and Keywords.

    a. Subject Classification Code - Chosen from the Subject Classification Guide (Appendix E of ESTSC–I), this one-letter code designation is to be supplied by the submitter.

    b. Keywords - Submitters should include keywords as taken from the ESTSC thesaurus listing (Appendix F of ESTSC–I). Keywords chosen that are not on the list will be subject to ESTSC approval before being added to the thesaurus. Subsequent revision lists will be available. ESTSC may also add additional keywords to aid in the indexing of the material.

    c. EDB Subject Categories - Energy-related categories (6-digit) to be assigned by ESTSC per the Energy Science and Technology Database (EDB) schema for a further breakdown of subject area.

17. Sponsor. This field, input by ESTSC from information provided on the Primary Submittal Form, represents the program office or division responsible for funding the software.

18. Material Available. This field, input by ESTSC, is taken from information provided on the submittal forms. It will be composed of:

    a. Contents of the package available for distribution.

    b. Computer media quantity.

19. Status. This field, input by ESTSC for submittals other than from SIACs, consists of a dialog of information concerning: when the package was announced; subsequent versions and dates; what level of testing has been performed at NESC, SIACs, or ESTSC; etc.

Note: The box above indicates data elements that will be determined by ESTSC, consisting of data extracted from other information provided within the submittal package.

Appendix C

DOE-APPROVED CRADA LANGUAGE

(To be provided to potential Participants on first contact, such as handouts at conferences and trade shows)

DOE-APPROVED CRADA LANGUAGE

Article I: DEFINITIONS
Article II: STATEMENT OF WORK
Article III: TERM, FUNDING AND COSTS
Article IV: PERSONAL PROPERTY
Article V: DISCLAIMER
Article VI: PRODUCT LIABILITY
Article VII: OBLIGATIONS AS TO PROPRIETARY INFORMATION
Article VIII: OBLIGATIONS AS TO PROTECTED CRADA INFORMATION
Article IX: RIGHTS IN GENERATED INFORMATION
Article X: EXPORT CONTROL
Article XI: REPORTS AND ABSTRACTS
Article XII: PRE-PUBLICATION REVIEW
Article XIII: COPYRIGHTS
Article XIV: REPORTING SUBJECT INVENTIONS
Article XV: TITLE TO SUBJECT INVENTIONS
Article XVI: FILING PATENT APPLICATIONS
Article XVII: TRADEMARKS
Article XVIII: MASK WORKS
Article XIX: COST OF INTELLECTUAL PROPERTY PROTECTION
Article XX: REPORTS OF INTELLECTUAL PROPERTY USE
Article XXI: DOE MARCH-IN RIGHTS
Article XXII: U.S. COMPETITIVENESS
Article XXIII: ASSIGNMENT OF PERSONNEL
Article XXIV: FORCE MAJEURE
Article XXV: ADMINISTRATION OF THE CRADA
Article XXVI: RECORDS AND ACCOUNTING FOR GOVERNMENT PROPERTY
Article XXVII: NOTICES
Article XXVIII: DISPUTES
Article XXIX: ENTIRE CRADA AND MODIFICATIONS
Article XXX: TERMINATION

Q7. You stated on page 4 of your prepared testimony that "[l]icensing of Government-owned patents is authorized by 35 U.S.C. 207-209, and implemented by Government-wide regulations issued by the Department of Commerce, 37 CFR 404."

Please provide a copy of these documents.

A7. Attached are copies of the texts of 35 U.S.C. 207-209 and 37 CFR 404.

manufacture substantially in the United States or that under the circumstances domestic manufacture is not commercially feasible.

(Added Pub.L. 96-517, § 6(a), Dec. 12, 1980, 94 Stat. 3023.)

Historical Note

Effective Date. Section effective July 1, 1981, but implementing regulations authorized to be issued earlier, see section 8(f) of Pub.L. 96-517, set out as an Effective Date of 1980 Amendment note under section 41 of this title.

Legislative History. For legislative history and purpose of Pub.L. 96-517, see 1980 U.S. Code Cong. and Adm.News, p. 6460.

Cross References

Authority of Office of Federal Procurement Policy to issue regulations applicable to Federal agencies to implement this section, see section 206 of this title.

Funding agreements to contain provisions to effectuate requirements of this section, see section 202 of this title.

Grant by Federal agency of nonexclusive, partially exclusive, or exclusive license because of waiver or breach of agreement to use or sell under this section, see section 203 of this title.

Code of Federal Regulations

Allocation of rights to inventions made in performance of National Science Foundation-assisted research, policies, procedures, and clauses governing, see 45 CFR 650.1 et seq.

Library References

Patents ⚿221.	C.J.S. Patents § 281.

§ 205. Confidentiality

Federal agencies are authorized to withhold from disclosure to the public information disclosing any invention in which the Federal Government owns or may own a right, title, or interest (including a nonexclusive license) for a reasonable time in order for a patent application to be filed. Furthermore, Federal agencies shall not be required to release copies of any document which is part of an application for patent filed with the United States Patent and Trademark Office or with any foreign patent office.

(Added Pub.L. 96-517, § 6(a), Dec. 12, 1980, 94 Stat. 3023.)

Historical Note

Effective Date. Section effective July 1, 1981, but implementing regulations authorized to be issued earlier, see section 8(f) of Pub.L. 96-517, set out as an Effective Date of 1980 Amendment note under section 41 of this title.

Legislative History. For legislative history and purpose of Pub.L. 96-517, see 1980 U.S. Code Cong. and Adm.News, p. 6460.

Code of Federal Regulations

Allocation of rights to inventions made in performance of National Science Foundation-assisted research, policies, procedures, and clauses governing, see 45 CFR 650.1 et seq.

Library References

Patents ⚿97.	C.J.S. Patents §§ 99 to 101, 109.

§ 206. Uniform clauses and regulations

The Office of Federal Procurement Policy, after receiving recommendations of the Office of Science and Technology Policy, may issue regulations which may be made applicable to Federal agencies implementing the provisions of sections 202 through 204 of this chapter and the Office of Federal Procurement Policy shall establish standard funding agreement provisions required under this chapter.

(Added Pub.L. 96-517, § 6(a), Dec. 12, 1980, 94 Stat. 3023.)

Historical Note

Effective Date. Section effective July 1, 1981, but implementing regulations authorized to be issued earlier, see section 8(f) of Pub.L. 96-517, set out as an Effective Date of 1980 Amendment note under section 41 of this title.

Legislative History. For legislative history and purpose of Pub.L. 96-517, see 1980 U.S. Code Cong. and Adm.News, p. 6460.

Code of Federal Regulations

Allocation of rights to inventions made in performance of National Science Foundation-assisted research, policies, procedures, and clauses governing, see 45 CFR 650.1 et seq.

Library References

Patents ⚿200.	C.J.S. Patents § 275 et seq.

§ 207. Domestic and foreign protection of federally owned inventions

Each Federal agency is authorized to—

(1) apply for, obtain, and maintain patents or other forms of protection in the United States and in foreign countries on inventions in which the Federal Government owns a right, title, or interest;

(2) grant nonexclusive, exclusive, or partially exclusive licenses under federally owned patent applications, patents, or other forms of protection obtained, royalty-free or for royalties or other consideration, and on such terms and conditions, including the grant to the licensee of the right of enforcement pursuant to the provisions of chapter 29 of this title as determined appropriate in the public interest;

(3) undertake all other suitable and necessary steps to protect and administer rights to federally owned inventions on behalf of the Federal Government either directly or through contract; and

(4) transfer custody and administration, in whole or in part, to another Federal agency, of the right, title, or interest in any federally owned invention.

(Added Pub.L. 96-517, § 6(a), Dec. 12, 1980, 94 Stat. 3023.)

Historical Note

Effective Date. Section effective July 1, 1981, but implementing regulations authorized to be issued earlier, see section 8(f) of Pub.L. 96-517, set out as an Effective Date of 1980 Amendment note under section 41 of this title.

Legislative History. For legislative history and purpose of Pub.L. 96-517, see 1980 U.S. Code Cong. and Adm.News, p. 6460.

Code of Federal Regulations

Allocation of rights to inventions made in performance of National Science Foundation-assisted research, policies, procedures, and clauses governing, see 45 CFR 650.1 et seq.

Licensing of National Aeronautics and Space Administration inventions, see 14 CFR 1245.200 et seq.

Library References

Patents 🔑90(1, 7), 221

C.J.S. Patents §§ 84 et seq., 280

§ 208. Regulations governing Federal licensing

The Administrator of General Services is authorized to promulgate regulations specifying the terms and conditions upon which any federally owned invention, other than inventions owned by the Tennessee Valley Authority, may be licensed on a nonexclusive, partially exclusive, or exclusive basis.

(Added Pub.L. 96-517, § 6(a), Dec. 12, 1980, 94 Stat. 3024.)

Historical Note

Effective Date. Section effective July 1, 1981, but implementing regulations authorized to be issued earlier, see section 8(f) of Pub.L. 96-517, set out as an Effective Date of 1980 Amendment note under section 41 of this title.

Legislative History. For legislative history and purpose of Pub.L. 96-517, see 1980 U.S. Code Cong. and Adm.News, p. 6460.

Code of Federal Regulations

Allocation of rights to inventions made in performance of National Science Foundation-assisted research, policies, procedures, and clauses governing, see 45 CFR 650.1 et seq.

Licensing of federally-owned inventions, see 38 CFR 1.666, 41 CFR 101-4.100 et seq.

Licensing of National Aeronautics and Space Administration inventions, see 14 CFR 1245.200 et seq.

Library References

Patents 🔑220

C.J.S. Patents § 275 et seq.

§ 209. Restrictions on licensing of federally owned inventions

(a) No Federal agency shall grant any license under a patent or patent application on a federally owned invention unless the person requesting the license has supplied the agency with a plan for development and/or marketing of the invention, except that any such plan may be treated by the Federal agency as commercial and financial information obtained from a person and privileged and confidential and not subject to disclosure under section 552 of title 5 of the United States Code.

(b) A Federal agency shall normally grant the right to use or sell any federally owned invention in the United States only to a licensee that agrees that any products embodying the invention or produced through the use of the invention will be manufactured substantially in the United States.

(c)(1) Each Federal agency may grant exclusive or partially exclusive licenses in any invention covered by a federally owned domestic patent or patent application only if, after public notice and opportunity for filing written objections, it is determined that—

(A) the interests of the Federal Government and the public will best be served by the proposed license, in view of the applicant's intentions, plans, and ability to bring the invention to practical application or otherwise promote the invention's utilization by the public;

(B) the desired practical application has not been achieved, or is not likely expeditiously to be achieved, under any nonexclusive license which has been granted, or which may be granted, on the invention;

(C) exclusive or partially exclusive licensing is a reasonable and necessary incentive to call forth the investment of risk capital and expenditures to bring the invention to practical application or otherwise promote the invention's utilization by the public; and

(D) the proposed terms and scope of exclusivity are not greater than reasonably necessary to provide the incentive for bringing the invention to practical application or otherwise promote the invention's utilization by the public.

(2) A Federal agency shall not grant such exclusive or partially exclusive license under paragraph (1) of this subsection if it determines that the grant of such license will tend substantially to lessen competition or result in undue concentration in any section of the country in any line of commerce to which the technology to be licensed relates, or to create or maintain other situations inconsistent with the antitrust laws.

(3) First preference in the exclusive and partially exclusive licensing of federally owned inventions shall go to small business firms submitting plans that are determined by the agency to be within the capabilities of the firms and equally likely, if executed, to bring the invention to practical application as any plans submitted by applicants that are not small business firms.

(d) After consideration of whether the interests of the Federal Government or United States industry in foreign commerce will be enhanced, any Federal agency may grant exclusive or partially exclusive licenses in any invention covered by a foreign patent application or patent, after public notice and opportunity for filing written objections, except that a Federal agency shall not grant such exclusive or partially exclusive license if it determines that the grant of such license will tend substantially to lessen competition or result in undue concentration in any section of the United States in any line of commerce to which the technology to be licensed relates, or to create or maintain other situations inconsistent with antitrust laws.

(e) The Federal agency shall maintain a record of determinations to grant exclusive or partially exclusive licenses.

(f) Any grant of a license shall contain such terms and conditions as the Federal agency determines appropriate for the protection of the interests of the Federal Government and the public, including provisions for the following

(1) periodic reporting on the utilization or efforts at obtaining utilization that are being made by the licensee with particular reference to the plan submitted: *Provided*, That any such information may be treated by the Federal agency as commercial and financial information obtained from a person and privileged and confidential and not subject to disclosure under section 552 of title 5 of the United States Code;

(2) the right of the Federal agency to terminate such license in whole or in part if it determines that the licensee is not executing the plan submitted with its request for a license and the licensee cannot otherwise demonstrate to the satisfaction of the Federal agency that it has taken or can be expected to take within a reasonable time, effective steps to achieve practical application of the invention;

(3) the right of the Federal agency to terminate such license in whole or in part if the licensee is in breach of an agreement obtained pursuant to paragraph (h) of this section; and

(4) the right of the Federal agency to terminate the license in whole or in part if the agency determines that such action is necessary to meet requirements for public use specified by Federal regulations issued after the date of the license and such requirements are not reasonably satisfied by the licensee.

(Added Pub L. 96–517, § 6(a), Dec. 12, 1980, 94 Stat. 3024.)

Historical Note

References in Text. Antitrust laws, referred to in subsecs (c)(2) and (d), are classified generally to chapter 1 (section 1 et seq) of Title 15, Commerce and Trade.

Effective Date. Section effective July 1, 1981, but implementing regulations authorized to be issued earlier, see section 8(f) of Pub L. 96–517, set out as an Effective Date of 1980 Amendment note under section 41 of this title.

Legislative History. For legislative history and purpose of Pub L. 96–517, see 1980 U S Code Cong & Adm.News, p. 6460

Code of Federal Regulations

Allocation of rights to inventions made in performance of National Science Foundation-assisted research, policies, procedures, and clauses governing, see 45 CFR 650.1 et seq.

Library References

Patents 🔑221. C.J.S. Patents § 280.

§ 210. Precedence of chapter

(a) This chapter shall take precedence over any other Act which would require a disposition of rights in subject inventions of small business firms or nonprofit organizations contractors in a manner that is inconsistent with this chapter, including but not necessarily limited to the following:

(1) section 10(a) of the Act of June 29, 1935, as added by title I of the Act of August 14, 1946 (7 U.S.C. 427i(a); 60 Stat. 1085);

(2) section 205(a) of the Act of August 14, 1946 U.S.C. 1624(a), 60 Stat. 1090);

(3) section 501(c) of the Federal Mine Safety and Health Act of 1977 (30 U.S.C. 951(c). 83 Stat. 742);

(4) section 106(c) of the National Traffic and Motor Vehicle Safety Act of 1966 (15 U.S.C 1395(c); 80 Stat. 721);

(5) section 12 of the National Science Foundation Act of 1950 (42 U.S.C 1871(a); 82 Stat. 360);

(6) section 152 of the Atomic Energy Act of 1954 (42 U.S.C 2182; 68 Stat 943);

(7) section 305 of the National Aeronautics and Space Act of 1958 (42 U.S.C. 2457);

(8) section 6 of the Coal Research Development Act of 1960 (30 U.S.C. 666; 74 Stat. 337);

(9) section 4 of the Helium Act Amendments of 1960 (50 U.S.C. 167b, 74 Stat. 920);

(10) section 32 of the Arms Control and Disarmament Act of 1961 (22 U.S.C. 2572; 75 Stat. 634);

(11) subsection (e) of section 302 of the Appalachian Regional Development Act of 1965 (40 U.S.C.App. 302(e); 79 Stat. 5);

(12) section 9 of the Federal Nonnuclear Energy Research and Development Act of 1974 (42 U.S.C 5901 [1]; 88 Stat. 1878);

(13) section 5(d) of the Consumer Product Safety Act (15 U.S.C 2054(d); 86 Stat. 1211);

(14) section 3 of the Act of April 5, 1944 (30 U.S.C 323; 58 Stat 191);

(15) section 8001(c)(3) of the Solid Waste Disposal Act (42 U.S.C. 6981(c); 90 Stat. 2829);

(16) section 219 of the Foreign Assistance Act of 1961 (22 U.S.C. 2179; 83 Stat. 806);

(17) section 427(b) of the Federal Mine Health and Safety Act of 1977 (30 U.S.C. 937(b); 86 Stat 155);

(18) section 306(d) of the Surface Mining and Reclamation Act of 1977 (30 U.S.C. 1226(d). 91 Stat. 455);

(19) section 21(d) of the Federal Fire Prevention and Control Act of 1974 (15 U.S.C. 2218(d); 88 Stat. 1548);

(20) section 6(b) of the Solar Photovoltaic Energy Research Development and Demonstration Act of 1978 (42 U.S.C. 5585(b); 92 Stat. 2516);

(21) section 12 of the Native Latex Commercialization and Economic Development Act of 1978 (7 U.S.C. 178(j) [2], 92 Stat. 2533); and

§ 204. Preference for United States industry

[See main volume for text of section]

(Added Pub.L. 96-517, § 6(a), Dec. 12, 1980, 94 Stat. 3023.)

§ 205. Confidentiality

NOTES OF DECISIONS

Federal agencies 2
State regulation or control 1

1. State regulation or control

There was no conflict for federal preemption purposes between Bayh-Dole Act which authorizes withholding from disclosure any information regarding invention in which federal government owns interest and Washington's Public Records Act, as type of information which may be withheld under Bayh-Dole Act fell within valuable formula of research data exemption to Public Records Act. Progressive Animal Welfare Soc. v. University of Washington, Wash. 1994, 884 P.2d 592, 125 Wash.2d 243, partial reconsideration denied.

2. Federal agencies

Confidentiality provisions of Bayh-Dole Act which authorizes withholding from disclosure any information regarding invention in which federal government owns interest applies only to federal agencies, and they merely authorize rather than mandate nondisclosure of information which would reveal invention in which federal government has right, title, or interest. Progressive Animal Welfare Soc. v. University of Washington, Wash.1994, 884 P.2d 592, 125 Wash.2d 243, partial reconsideration denied.

§ 206. Uniform clauses and regulations

The Secretary of Commerce may issue regulations which may be made applicable to Federal agencies implementing the provisions of sections 202 through 204 of this chapter and shall establish standard funding agreement provisions required under this chapter. The regulations and the standard funding agreement shall be subject to public comment before their issuance.

(As amended Pub.L. 98-620, Title V, § 501(10), Nov. 8, 1984, 98 Stat. 3367.)

HISTORICAL AND STATUTORY NOTES

1984 Amendment

Pub.L. 98-620 substituted "The Secretary of Commerce" for "The Office of Federal Procurement Policy, after receiving recommendations of the Office of Science and Technology Policy," and "shall establish" for "the Office of Federal Procurement Policy shall establish", respectively, and added provisions that the regulations and the standard funding agreement shall be subject to public comment before their issuance.

Legislative History

For legislative history and purpose of Pub.L. 98-620, see 1984 U.S. Code Cong. and Adm. News, p. 5708.

§ 207. Domestic and foreign protection of federally owned inventions

(a) Each Federal agency is authorized to—

[See main volume for text of (1) to (4)]

(b) For the purpose of assuring the effective management of Government-owned inventions, the Secretary of Commerce is authorized to—

(1) assist Federal agency efforts to promote the licensing and utilization of Government-owned inventions;

(2) assist Federal agencies in seeking protection and maintaining inventions in foreign countries, including the payment of fees and costs connected therewith; and

(3) consult with and advise Federal agencies as to areas of science and technology research and development with potential for commercial utilization.

(As amended Pub.L. 98-620, Title V, § 501(11), Nov. 8, 1984, 98 Stat. 3367.)

HISTORICAL AND STATUTORY NOTES

1984 Amendment

Subsec. (a). Pub.L. 98-620, designated existing provisions as subsec. (a).

Subsec. (b). Pub.L. 98-620, added subsec. (b).

Legislative History

For legislative history and purpose of Pub.L. 98-620, see 1984 U.S. Code Cong. and Adm. News, p. 5708.

LAW REVIEW COMMENTARIES

The exercise of patent rights through multiple exclusive field-of-use licensing. S. Leslie Misrock, Brian D. Coggio, and Norman C. Dulak (1985) 11 Rutgers Computer & Tech Law J. 383.

§ 208. Regulations governing Federal licensing

The Secretary of Commerce is authorized to promulgate regulations specifying the terms and conditions upon which any federally owned invention, other than inventions owned by the Tennessee Valley Authority, may be licensed on a nonexclusive, partially exclusive, or exclusive basis.

(As amended Pub.L. 98-620, Title V, § 501(12), Nov. 8, 1984, 98 Stat. 3367.)

HISTORICAL AND STATUTORY NOTES

1984 Amendment

Pub.L. 98-620 substituted "Secretary of Commerce" for "Administrator of General Services".

Legislative History

For legislative history and purpose of Pub.L. 98-620, see 1984 U.S. Code Cong. and Adm. News, p. 5708.

§ 209. Restrictions on licensing of federally owned inventions

LAW REVIEW COMMENTARIES

The exercise of patent rights through multiple exclusive field-of-use licensing. S. Leslie Misrock, Brian D. Coggio, and Norman C. Dulak (1985) 11 Rutgers Computer & Tech Law J. 383.

§ 210. Precedence of chapter

(a) This chapter shall take precedence over any other Act which would require a disposition of rights in subject inventions of small business firms or nonprofit organizations contractors in a manner that is inconsistent with this chapter, including but not necessarily limited to the following:

[See main volume for text of (1) to (3)]

(4) section 30168(e) of title 49;

[See main volume for text of (5) to (22)]

The Act creating this chapter shall be construed to take precedence over any future Act unless that Act specifically cites this Act and provides that it shall take precedence over this Act.

[See main volume for text of (b)]

(c) Nothing in this chapter is intended to limit the authority of agencies to agree to the disposition of rights in inventions made in the performance of work under funding agreements with persons other than nonprofit organizations or small business firms in accordance with the Statement of Government Patent Policy issued on February 18, 1983, agency regulations, or other applicable regulations or to otherwise limit the authority of agencies to allow such persons to retain ownership of inventions except that all funding agreements, including those with other than small business firms and nonprofit organizations, shall include the requirements established in paragraph 202(c)(4) and section 203 of this title..[1] Any disposition of rights in inventions made in accordance with the Statement or implementing regulations, including any disposition occurring before enactment of this section, are hereby authorized.

[See main volume for text of (d)]

(e) The provisions of the Stevenson-Wydler Technology Innovation Act of 1980, as amended by the Federal Technology Transfer Act of 1986, shall take precedence over the provisions of this chapter to the extent that they permit or require a disposition of rights in subject inventions which is inconsistent with this chapter.

(As amended Pub.L. 98-620, Title V, § 501(13), Nov. 8, 1984, 98 Stat. 3367; Pub.L. 99-502, § 9(c), Oct. 20, 1986, 100 Stat. 1796; Pub.L. 103-272, § 5(j), July 5, 1994, 108 Stat. 1375.)

---

[1] So in original.

those in the clause at § 401.14(a), unless made by the head of the agency, shall be appealable by the contractor to an agency official at a level above the person who made the determination. This appeal shall be subject to the procedures applicable to appeals under § 401.11 of this part.

§ 401.16 Electronic filing.

Unless otherwise requested or directed by the agency,

(a) The written report required in (c)(1) of the standard clause in § 401.14(a) may be electronically filed;

(b) The written election required in (c)(2) of the standard clause in § 401.14(a) may be electronically filed; and

(c) The close-out report in (f)(1) and the information identified in (f)(2) and (f)(3) of § 401.5 may be electronically filed.

[60 FR 41812, Aug. 14, 1995]

§ 401.17 Submissions and inquiries.

All submissions or inquiries should be directed to Director, Technology Competitiveness Staff, Office of Technology Policy, Technology Administration, telephone number 202-482-2100, Room H4418, U.S. Department of Commerce, Washington, DC 20230.

[60 FR 41812, Aug. 14, 1995]

PART 404—LICENSING OF GOVERNMENT OWNED INVENTIONS

Sec.
404.1 Scope of part.
404.2 Policy and objective.
404.3 Definitions.
404.4 Authority to grant licenses.
404.5 Restrictions and conditions on all licenses granted under this part.
404.6 Nonexclusive licenses.
404.7 Exclusive and partially exclusive licenses.
404.8 Application for a license.
404.9 Notice to Attorney General.
404.10 Modification and termination of licenses.
404.11 Appeals.
404.12 Protection and administration of inventions.
404.13 Transfer of custody.
404.14 Confidentiality of information.

AUTHORITY: 35 U.S.C. 208 and the delegation of authority by the Secretary of Commerce to the Assistant Secretary of Commerce for Technology Policy at sec. 3(g) of DOO 10-18.

SOURCE: 50 FR 9802, Mar. 12, 1985, unless otherwise noted.

§ 404.1 Scope of part.

This part prescribes the terms, conditions, and procedures upon which a federally owned invention, other than an invention in the custody of the Tennessee Valley Authority, may be licensed. It supersedes the regulations at 41 CFR Subpart 101-4.1. This part does not affect licenses which (a) were in effect prior to July 1, 1981; (b) may exist at the time of the Government's acquisition of title to the invention, including those resulting from the allocation of rights to inventions made under Government research and development contracts; (c) are the result of an authorized exchange of rights in the settlement of patent disputes; or (d) are otherwise authorized by law or treaty.

§ 404.2 Policy and objective.

It is the policy and objective of this subpart to use the patent system to promote the utilization of inventions arising from federally supported research or development.

§ 404.3 Definitions.

(a) *Federally owned invention* means an invention, plant, or design which is covered by a patent, or patent application in the United States, or a patent, patent application, plant variety protection, or other form of protection, in a foreign country, title to which has been assigned to or otherwise vested in the United States Government.

(b) *Federal agency* means an executive department, military department, Government corporation, or independent establishment, except the Tennessee Valley Authority, which has custody of a federally owned invention.

(c) *Small business firm* means a small business concern as defined in section 2 of Pub. L. 85-536 (15 U.S.C. 632) and implementing regulations of the Administrator of the Small Business Administration.

(d) *Practical application* means to manufacture in the case of a composition or product, to practice in the case of a process or method, or to operate in the case of a machine or system; and, in each case, under such conditions as to establish that the invention is being utilized and that its benefits are to the extent permitted by law or Government regulations available to the public on reasonable terms.

(e) *United States* means the United States of America, its territories and possessions, the District of Columbia, and the Commonwealth of Puerto Rico.

§ 404.4 Authority to grant licenses.

Federally owned inventions shall be made available for licensing as deemed appropriate in the public interest. Federal agencies having custody of federally owned inventions may grant nonexclusive, partially exclusive, or exclusive licenses thereto under this part.

§ 404.5 Restrictions and conditions on all licenses granted under this part.

(a)(1) A license may be granted only if the applicant has supplied the Federal agency with a satisfactory plan for development or marketing of the invention, or both, and with information about the applicant's capability to fulfill the plan.

(2) A license granting rights to use or sell under a federally owned invention in the United States shall normally be granted only to a licensee who agrees that any products embodying the invention or produced through the use of the invention will be manufactured substantially in the United States.

(b) Licenses shall contain such terms and conditions as the Federal agency determines are appropriate for the protection of the interests of the Federal Government and the public and are not in conflict with law or this part. The following terms and conditions apply to any license:

(1) The duration of the license shall be for a period specified in the license agreement, unless sooner terminated in accordance with this part.

(2) The license may be granted for all or less than all fields of use of the invention or in specified geographical areas, or both.

(3) The license may extend to subsidiaries of the licensee or other parties if provided for in the license but shall be nonassignable without approval of the Federal agency, except to the successor of that part of the licensee's business to which the invention pertains.

(4) The licensee may provide the licensee the right to grant sublicenses under the license, subject to the approval of the Federal agency. Each sublicense shall make reference to the license, including the rights retained by the Government, and a copy of such sublicense shall be furnished to the Federal agency.

(5) The license shall require the licensee to carry out the plan for development or marketing of the invention, or both, to bring the invention to practical application within a period specified in the license, and to continue to make the benefits of the invention reasonably accessible to the public.

(6) The license shall require the licensee to report periodically on the utilization or efforts at obtaining utilization that are being made by the licensee, with particular reference to the plan submitted.

(7) Licenses may be royalty-free or for royalties or other consideration.

(8) Where an agreement is obtained pursuant to § 404.5(a)(2) that any products embodying the invention or produced through use of the invention will be manufactured substantially in the United States, the license shall recite such agreement.

(9) The license shall provide for the right of the Federal agency to terminate the license, in whole or in part, if:

(i) The Federal agency determines that the licensee is not executing the plan submitted with its request for a license and the licensee cannot otherwise demonstrate to the satisfaction of the Federal agency that it has taken or can be expected to take within a reasonable time effective steps to achieve practical application of the invention;

(ii) The Federal agency determines that such action is necessary to meet requirements for public use specified by Federal regulations issued after the date of the license and such requirements are not reasonably satisfied by the licensee;

(iii) The licensee has willfully made a false statement of or willfully omitted a material fact in the license application or in any report required by the license agreement; or

(iv) The licensee commits a substantial breach of a covenant or agreement contained in the license.

(10) The license may be modified or terminated, consistent with this part, upon mutual agreement of the Federal agency and the licensee.

(11) Nothing relating to the grant of a license, nor the grant itself, shall be construed to confer upon any person any immunity from or defenses under the antitrust laws or from a charge of patent misuse, and the acquisition and use of rights pursuant to this part shall not be immunized from the operation of state or Federal law by reason of the source of the grant.

§ 404.6 Nonexclusive licenses.

(a) Nonexclusive licenses may be granted under federally owned inventions without publication of availability or notice of a prospective license.

(b) In addition to the provisions of § 404.5, the nonexclusive license may also provide that, after termination of a period specified in the license agreement, the Federal agency may restrict the license to the fields of use or geographic areas, or both, in which the licensee has brought the invention to practical application and continues to make the benefits of the invention reasonably accessible to the public. However, such restriction shall be made only in order to grant an exclusive or partially exclusive license in accordance with this subpart.

§ 404.7 Exclusive and partially exclusive licenses.

(a)(1) Exclusive or partially exclusive domestic licenses may be granted on federally owned inventions three months after notice of the invention's availability has been announced in the Federal Register, or without such notice where the Federal agency determines that expeditious granting of such a license will best serve the interest of the Federal Government and the public; and in either situation, only if:

(i) Notice of a prospective license, identifying the invention and the prospective licensee, has been published in the Federal Register, providing opportunity for filing written objections within a 60-day period;

(ii) After expiration of the period in § 404.7(a)(1)(i) and consideration of any written objections received during the period, the Federal agency has determined that:

(A) The interests of the Federal Government and the public will best be served by the proposed license, in view of the applicant's intentions, plans, and ability to bring the invention to practical application or otherwise promote the invention's utilization by the public;

(B) The desired practical application has not been achieved, or is not likely expeditiously to be achieved, under any nonexclusive license which has been granted, or which may be granted, on the invention;

(C) Exclusive or partially exclusive licensing is a reasonable and necessary incentive to call forth the investment of risk capital and expenditures to bring the invention to practical application or otherwise promote the invention's utilization by the public; and

(D) The proposed terms and scope of exclusivity are not greater than reasonably necessary to provide the incentive for bringing the invention to practical application or otherwise promote the invention's utilization by the public;

(iii) The Federal agency has not determined that the grant of such license will tend substantially to lessen competition or result in undue concentration in any section of the country in any line of commerce to which the technology to be licensed relates, or to create or maintain other situations inconsistent with the antitrust laws; and

(iv) The Federal agency has given first preference to any small business firms submitting plans that are determined by the agency to be within the capabilities of the firms and as equally likely, if executed, to bring the invention to practical application as any plans submitted by applicants that are not small business firms.

(2) In addition to the provisions of § 404.5, the following terms and conditions apply to domestic exclusive and partially exclusive licenses:

(i) The license shall be subject to the irrevocable, royalty-free right of the Government of the United States to

practice and have practiced the invention on behalf of the United States and on behalf of any foreign government or international organization pursuant to any existing or future treaty or agreement with the United States.

(ii) The license shall reserve to the Federal agency the right to require the licensee to grant sublicenses to responsible applicants, on reasonable terms, when necessary to fulfill health or safety needs.

(iii) The license shall be subject to any licenses in force at the time of the grant of the exclusive or partially exclusive license.

(iv) The license may grant the licensee the right of enforcement of the licensed patent pursuant to the provisions of Chapter 29 of Title 35, United States Code, or other statutes, as determined appropriate in the public interest.

(b)(1) Exclusive or partially exclusive licenses may be granted on a federally owned invention covered by a foreign patent, patent application, or other form of protection, provided that;

(i) Notice of a prospective license, identifying the invention and prospective licensee, has been published in the Federal Register, providing opportunity for filing written objections within a 60-day period and following consideration of such objections;

(ii) The agency has considered whether the interests of the Federal Government or United States industry in foreign commerce will be enhanced; and

(iii) The Federal agency has not determined that the grant of such license will tend substantially to lessen competition or result in undue concentration in any section of the United States in any line of commerce to which the technology to be licensed relates, or to create or maintain other situations inconsistent with antitrust laws.

(2) In addition to the provisions of § 404.5 the following terms and conditions apply to foreign exclusive and partially exclusive licenses:

(i) The license shall be subject to the irrevocable, royalty-free right of the Government of the United States to practice and have practiced the invention on behalf of the United States and on behalf of any foreign government or international organization pursuant to any existing or future treaty or agreement with the United States.

(ii) The license shall be subject to any licenses in force at the time of the grant of the exclusive or partially exclusive license.

(iii) The license may grant the licensee the right to take any suitable and necessary actions to protect the licensed property, on behalf of the Federal Government.

(c) Federal agencies shall maintain a record of determinations to grant exclusive or partially exclusive licenses.

§ 404.8 Application for a license.

An application for a license should be addressed to the Federal agency having custody of the invention and shall normally include:

(a) Identification of the invention for which the license is desired including the patent application serial number or patent number, title, and date, if known;

(b) Identification of the type of license for which the application is submitted;

(c) Name and address of the person, company, or organization applying for the license and the citizenship or place of incorporation of the applicant;

(d) Name, address, and telephone number of the representative of the applicant to whom correspondence should be sent;

(e) Nature and type of applicant's business, identifying products or services which the applicant has successfully commercialized, and approximate number of applicant's employees;

(f) Source of information concerning the availability of a license on the invention;

(g) A statement indicating whether the applicant is a small business firm as defined in § 404.3(c).

(h) A detailed description of applicant's plan for development or marketing of the invention, or both, which should include:

(1) A statement of the time, nature and amount of anticipated investment of capital and other resources which applicant believes will be required to bring the invention to practical application;

(2) A statement as to applicant's capability and intention to fulfill the plan, including information regarding manufacuturing, marketing, financial, and technical resources;

(3) A statement of the fields of use for which applicant intends to practice the invention; and

(4) A statement of the geographic areas in which applicant intends to manufacture any products embodying the invention and geographic areas where applicant intends to use or sell the invention, or both;

(i) Identification of licenses previously granted to applicant under federally owned inventions;

(j) A statement containing applicant's best knowledge of the extent to which the invention is being practiced by private industry or Government, or both, or is otherwise available commercially; and

(k) Any other information which applicant believes will support a determination to grant the license to applicant.

§ 404.9 Notice to Attorney General.

A copy of the notice provided for in § 404.7 (a)(1)(i) and (b)(1)(i) will be sent to the Attorney General.

§ 404.10 Modification and termination of licenses.

Before modifying or terminating a license, other than by mutual agreement, the Federal agency shall furnish the licensee and any sublicensee of record a written notice of intention to modify or terminate the license, and the licensee and any sublicensee shall be allowed 30 days after such notice to remedy any breach of the license or show cause why the license shall not be modified or terminated.

§ 404.11 Appeals.

In accordance with procedures prescribed by the Federal agency, the following parties may appeal to the agency head or designee any decision or determination concerning the grant, denial, interpretation, modification, or termination of a license:

(a) A person whose application for a license has been denied.

(b) A licensee whose license has been modified or terminated, in whole or in part; or

(c) A person who timely filed a written objection in response to the notice required by § 404.7(a)(1)(i) or § 404.7(b)(1)(i) and who can demonstrate to the satisfaction of the Federal agency that such person may be damaged by the agency action.

§ 404.12 Protection and administration of inventions.

A Federal agency may take any suitable and necessary steps to protect and administer rights to federally owner inventions, either directly or through contract.

§ 404.13 Transfer of custody.

A Federal agency having custody of a federally owned invention may transfer custody and administration, in whole or in part, to another Federal agency, of the right, title, or interest in such invention.

§ 404.14 Confidentiality of information.

Title 35, United States Code, section 209, provides that any plan submitted pursuant to § 404.8(h) and any report required by § 404.5(b)(6) may be treated by the Federal agency as commercial and financial information obtained from a person and privileged and confidential and not subject to disclosure under section 552 of Title 5 of the United States Code.

Q8. You also stated on page 4 of your prepared testimony that "DOE implemented the cost sharing requirements of EPACT immediately upon enactment, and issued final guidelines in March 1996 by Acquisition Letter 96-04 and Financial Assistance Letter 96-01."

Q8a. Please provides copies of Acquisition Letter 96-04 and Financial Assistance Letter 96-01.

A8a. Attached are copies of the texts of Acquisition Letter 96-04 and Financial Assistance Letter 96-01.

Department of Energy
Acquisition Regulation

No. 96-04
Date March 8, 1996.

ACQUISITION LETTER

AUTHORITY

This Acquisition Letter is issued by the Procurement Executive pursuant to a delegation from the Secretary and under the authority of the Department of Energy Acquisition Regulation (DEAR) subsections 901.301-70 and 901.301-71.

****

I. Purpose. The purpose of this Acquisition Letter is to provide implementation guidance on sections 3001 and 3002 of the Energy Policy Act, (EPAct) 42 U.S.C. 13542 for acquisition awards.

II. Background. Sections 3001 and 3002 provide general provisions covering the research, development, demonstration, and commercial application activities to be carried out under EPAct. Section 3001 authorizes the Secretary to carry out research, development, demonstration and commercial application programs through the use of contracts, cooperative agreements, grants, cooperative research and development agreements, and joint ventures. It also extends the protection of information coverage of the Stevenson-Wydler Technology Innovation Act of 1980, 15 U.S.C. 3710 a(c)(7) to research, development, demonstration, and commercial application programs and activities under EPAct.

Section 3002 imposes cost sharing requirements for such activities. For research and development programs, the Secretary shall require a commitment from non-Federal sources of at least 20 percent of the cost of the project. For demonstration and commercial application programs, the Secretary shall require at least 50 percent of the costs directly and specifically related to any demonstration or commercial application project to be provided from non-Federal sources.

The Secretary may reduce or eliminate the non-Federal requirement for cost sharing for research and development programs if the Secretary determines that the research and development is of a basic or fundamental nature. For demonstration and commercial application programs, the Secretary may reduce the non-Federal requirement if the reduction is necessary and appropriate considering the technological risks involved in the project and the project is necessary to meet the objectives of EPAct.

Printed with soy ink on recycled paper

In calculating the amount of the non-Federal commitment, the Secretary shall include cash, personnel, services, equipment, and other resources.

III. Guidance.

A. Applicability

The requirements of Sections 3001 and 3002 apply to contracts for research and development, demonstration, and commercial application projects under an EPAct covered program which are made on or after October 24, 1992, the effective date of EPAct.

Any new contracts awarded after the effective date of this Acquisition Letter must contain the cost sharing requirement.

The Department of Energy has determined that programs executed under the authority of the Small Business Innovation Research and Small Business Technology Transfer programs are not covered under EPACT.

B. Contracting Officer Responsibilities.

Contracting officers shall include the following information in any solicitation for research and development, demonstration, and commercial application programs covered under EPACT:

(1) Protection of Information. The provisions of Section 12(c)(7) of the Stevenson-Wydler Technology Innovation Act of 1980, relating to the protection of information, shall apply to research, development, demonstration, and commercial application programs and activities under this Act. These provisions specify:

- The protection from public disclosure of trade secrets or financial or commercial information that is privileged or confidential and obtained in the conduct of research or as a result of activities under this Act from a non-Federal party to a covered contract.
- The protection from public disclosure, for a period of up to five years from development, of information resulting from the contract that would be a trade secret or commercial or financial information that is privileged or confidential if the information had been obtained from a non-Federal party to a covered contract. This protection from public disclosure includes exemption from disclosure pursuant to 5 U.S.C. 552(b) (The Freedom of Information Act.)

The Contracting Officer shall coordinate with DOE Patent Counsel prior to award of any contract covered under EPAct to assure appropriate intellectual property provisions. In no event shall the Contracting

Officer construe the data protection provisions to apply to information or data generated by M&O contractors under their prime contract with the Department.

(2) Cost sharing requirement. Contractor proposals must show the requisite cost sharing commitment. The following is suggested language which could be included in solicitations.

Cost Sharing Requirement

EPACT 3002 requires a cost sharing commitment of 20 percent from non-Federal sources for research and development projects. For demonstration or commercial application projects, the cost sharing requirement from non-Federal sources is 50 percent. Your cost proposal must show the breakout between Federal and non-Federal sources and how you propose to meet the cost sharing requirement. The non-Federal share may include cash, personnel, services, equipment, and other resources.

All cost sharing or matching contributions, including cash and third party in-kind, shall meet the following criteria:

(1) are verifiable from the contractor's records,

(2) are not included as contributions for any other federally-assisted project or program,

(3) are necessary and reasonable for proper and efficient accomplishment of project or program objectives,

(4) are allowable under the applicable cost principles,

(5) are not paid by the Federal Government under another award, except where authorized by Federal statute to be used for cost sharing or matching.

Values for contractor contributions of services and property shall be established in accordance with applicable cost principles.

Volunteer services furnished by professional and technical personnel, consultants, and other skilled and unskilled labor may be counted as cost sharing or matching if the service is an integral and necessary part of an approved project or program. Rates for volunteer services shall be consistent with those paid for similar work in the contractor's organization. In those instances in which the required skills are not found in the contractor organization, rates shall be consistent with those paid for similar work in the labor market in which the contractor competes for the kind of services involved.

In addition to including the appropriate information in solicitations, the contracting officer must also ensure that the award document incorporates the cost sharing requirement and the cost sharing is obtained.

C. Waiver of cost sharing requirement.

The Secretary has delegated the authority to make the determinations waiving the section 3002 non-Federal cost sharing requirement to the Deputy Assistant Secretary for Procurement and Assistance Management. The Deputy Assistant Secretary for Procurement and Assistance Management, by separate document, redelegated authority to make EPAct cost sharing determinations to the Heads of Contracting Activities (HCAs) and, with respect to the financial assistance under the Office of Energy Research Program Rule, 10 CFR Part 605, to the Director, Office of Energy Research.

Any determination waiving or reducing a cost sharing requirement must be based on the section 3002 criteria. For research and development programs, DOE must determine that the research and development is of a basic or fundamental nature.

For demonstration and commercial application programs, the determination must show that the reduction is necessary and appropriate considering the technological risks involved in the project and the project is necessary to meet the objectives of EPAct. This determination should be based on demonstrated results of activities such as the following:

(1) solicitations. The contracting activity has attempted to obtain cost sharing, but industry and others did not respond to the solicitation.

(2) other studies. Market surveys or other studies have been conducted which provide significant data that commercial organizations are not willing to participate in the financial assistance program or other activity because of the cost sharing requirements.

IV. Effective Date. This Acquisition Letter is effective upon issuance.

V. Expiration Date. This Acquisition Letter will remain in effect until cancelled.

VI. Covered Programs. The attached listing identifies EPAct covered programs.

AL 96-04 (3/08/96)
Attachment

COVERED PROGRAMS- § 3002	**EPACT SECTIONS**
Fossil Energy R & D	
Coal *All Programs Including*	§ 1301-1312
Coal-fired Diesel Engines	§ 1302
Clean Coal, Waste-To-Energy	§ 1303
Nonfuel Use of Coal	§ 1304
Coal Refinery Program	§ 1305
Coalbed Methane Recovery	§ 1306
Metallurgical Coal Development	§ 1307
Utilization of Coal Wastes	§ 1308
Underground Coal Gasification	§ 1309
Low-rank Coal Research and Development	§ 1310
Magnetohydrodynamics	§ 1311
Oil Substitution Through Coal Liquefaction	§ 1312
Clean Coal Technology	§ 1321

COVERED PROGRAMS - § 3002	**EPACT SECTIONS**
Fossil Energy R & D	
Petroleum	
Enhanced Oil Recovery All Programs Including:	§ 2011
Heavy Oil	§ 2011
Light Oil	§ 2011
Tar Sands	§ 2011
Advanced Extraction & Process Tech All Programs Including:	§ 2011
Geological Science/Extract Research	§ 2011
SPT Technology/Environmental Research	§ 2011
University Geoscience Research	§ 2011
Oil Shale All Programs:	§ 2012
Gas	
Natural Gas Research All Programs Including:	§ 2013-2015
Resource & Extraction	§ 2013, 2014
Delivery & Storage	§ 2013, 2014
Utilization	§ 2013, 2014
Environmental Research & Regulatory Analysis	§ 2013, 2014
Midcontinent Energy Research Center*	§ 2013, 2015
Fuel Cells All Programs Including:	§ 2115
Advanced Research	§ 2115
Phosphoric Acid Systems	§ 2115
Molten Carbonate Systems	§ 2115
Advanced Concepts	§ 2115
Energy Conservation	
Transportation All Programs Including:	§ 2021-2025, 2027, 2028, 2112
Alternative Fuels Utilization	§ 2021, 2023
Materials Development	§ 2021
Heat Engine Development	§ 2021, 2112
Electric & Hybrid Propulsion Development	§ 2021, 2025
Implementation & Deployment	§ 2021
Management	§ 2021

Management-Capital Equipment	§ 2021
Advanced Automotive Fuel Economy	§ 2021, 2022
*Biofuels User Facility**	§ 2021, 2024
*Advanced Diesel Emissions Program**	§ 2021, 2027
*Telecommuting Study**	§ 2021, 2028
Utility All Programs Including:	§ 2101
Integrated Resource Planning	§ 2101
Program Direction-IRP	§ 2101
Energy Management Control	§ 2101
Industry All Programs Including:	§ 2101-2108
Industrial Wastes	§ 2101
Municipal Solid Wastes	§ 2101
Cogeneration	§ 2101
Electric Drives	§ 2101, 2105
Materials Processing	§ 2101, 2107
Separations	§ 2101
Sensors & Controls	§ 2101
Bioprocessing	§ 2101
Enabling Materials	§ 2101
Improved Combustion Efficiency	§ 2101, 2107
Process Heating & Cooling	§ 2101, 2102
Implementation & Deployment	§ 2101
Management	§ 2101
Management-Capital Equipment	§ 2101
*National Advanced Manufacturing Tech Initiative**	§ 2101, 2202
*Pulp & Paper**	§ 2101, 2103
*Steel, Aluminum, and Metal Research**	§ 2101, 2106
*Energy Efficient Environmental Program**	§ 2101, 2108
Buildings All Programs Including:	§ 2101-2108
Solar Technologies	§ 2101
Materials & Structures	§ 2101
Lighting & Appliances	§ 2101
Heating & Cooling Equipment	§ 2101, 2102
Indoor Air Quality	§ 2101
Building Systems Research	§ 2101
Federal Energy Management Program	§ 2101
Implementation & Deployment	§ 2101
Management	§ 2101
Management-Capital Equipment	§ 2101

*Advanced Buildings for 2005**	§ 2101, 2104
Energy Supply R & D	
Energy Research	
Fusion Energy All Programs Including:	§ 2114
Confinement Systems	§ 2114
Development & Technology	§ 2114
Applied Plasma Physics	§ 2114
Planning & Projects	§ 2114
Inertial Fusion Energy	§ 2114
Program Direction-Op Exp	§ 2114
Capital Equipment & Construction	§ 2114
Basic Energy Sciences All Programs Including:	§ 2203
Materials Sciences	§ 2203
Chemical Sciences	§ 2203
Energy Biosciences	§ 2203
Engineering & Geosciences	§ 2203
Applied Math Sciences	§ 2203, 2204
Advanced Energy Projects	§ 2203
Advanced Neutron Source	§ 2203
Program Direction	§ 2203
Capital Equipment	§ 2203
Advisory & Oversight/Program Direction	§ 2203
Energy Research Analysis	§ 2203
University & Science Education Programs	§ 2203
*Experimental Program to Stimulate Competitive Research**	§ 2203
Laboratory Technology Transfer	§ 2203
Multi-Program Laboratory Support	§ 2203
Nuclear Energy	
Light Water Reactor	§ 2123, 2126
Advanced Reactor R&D	§ 2121, 2122 2124, 2126
Facilities	§ 2126
Solar & Renewables	
Solar & Other Energy All Programs Including:	§ 2021, 2026, § 2111, 2117
Photovoltaics	§ 2111
Biofuels	§ 2021
Solar Technology Transfer	§ 2111
NREL	§ 2111

Program Direction- Other Solar Energy	§ 2111
Solar Building Technology Research	§ 2111
Solar Thermal Energy Systems	§ 2111
Wind Energy Systems	§ 2111
Ocean Energy System	§ 2111
International Solar Energy Program	§ 2111
Resource Assessment	§ 2111
Program Support	§ 2111
Geothermal	§ 2111
Hydrogen Research	§ 2026
Electric Energy Systems including: Superconductivity	§ 2117, 2111
Energy Storage Systems	§ 2111
Environmental Restoration & Waste Management	
Facility Transition-Fast Flux Test Facility	§ 2116
Civilian Waste R & D	§ 2113
Electric & Magnetic Fields Research and Public Dissemination Program*	§ 2118
Spark M. Matsunga Renewable Energy & Ocean Technology Center*	§ 2111, 2119

*Direct citation from Title XX-XXIII.

Department of Energy

No. 96-01

Date March 8, 1996

FINANCIAL ASSISTANCE LETTER

Authority

This Financial Assistance Letter is issued by the Procurement Executive pursuant to a delegation from the Secretary.

* * *

I. Purpose. The purpose of this Financial Assistance Letter is to provide implementation guidance on sections 3001 and 3002 of the Energy Policy Act, (EPAct) 42 U.S.C. 13542 for financial assistance awards.

II. Background. Sections 3001 and 3002 provide general provisions covering the research, development, demonstration, and commercial application activities to be carried out under EPAct. Section 3001 authorizes the Secretary to carry out research, development, demonstration and commercial application programs through the use of contracts, cooperative agreements, grants, cooperative research and development agreements, and joint ventures. It also extends the protection of information coverage of the Stevenson-Wydler Technology Innovation Act of 1980, 15 U.S.C. 3710 a(c)(7) to research, development, demonstration, and commercial application programs and activities under EPAct.

Section 3002 imposes cost sharing requirements for such activities. For research and development programs, the Secretary shall require a commitment from non-Federal sources of at least 20 percent of the cost of the project. For demonstration and commercial application programs, the Secretary shall require at least 50 percent of the costs directly and specifically related to any demonstration or commercial application project to be provided from non-Federal sources.

The Secretary may reduce or eliminate the non-Federal requirement for cost sharing for research and development programs if the Secretary determines that the research and development is of a basic or fundamental nature. For demonstration and commercial application programs, the Secretary may reduce the non-Federal requirement if the reduction is necessary and appropriate considering the technological risks involved in the project and the project is necessary to meet the objectives of EPAct.

III. Guidance.

A. Applicability

The requirements of Sections 3001 and 3002 apply to grants and cooperative agreements for research and development, demonstration, and commercial application projects under an EPAct covered program which are made on or after October 24, 1992, the effective date of EPAct..

For the purpose of the cost sharing requirements under Section 3002, financial assistance actions awarded prior to October 24, 1992, will not be subject to a cost sharing requirement unless the project is proposed for a renewal award. For financial assistance actions awarded on or after the effective date of EPAct, for which no cost sharing was obtained, cost sharing must be required for the next continuation of the project.

The Department of Energy has determined that programs executed under the authority of the Small Business Innovation Research and Small Business Technology Transfer programs are not covered under EPACT.

B. Contracting Officer Responsibilities.

Contracting officers shall include the following information in any solicitation for research and development, demonstration, and commercial application programs covered under EPACT:

(1) Protection of Information. The provisions of Section 12(c)(7) of the Stevenson-Wydler Technology Innovation Act of 1980, relating to the protection of information, shall apply to research, development, demonstration, and commercial application programs and activities under this Act. These provisions specify:

- The protection from public disclosure of trade secrets or financial or commercial information that is privileged or confidential and obtained in the conduct of research or as a result of activities under this Act from a non-Federal party to a financial assistance award.
- The protection from public disclosure, for a period of up to five years from development, of information resulting from the financial assistance activities that would be a trade secret or commercial or financial information that is privileged or confidential if the information had been obtained from a non-Federal party to a financial assistance award. This protection from public disclosure includes exemption from disclosure pursuant to 5 U.S.C. 552(b) (The Freedom of Information Act.)

The Contracting Officer shall coordinate with DOE Patent Counsel prior to award of any financial assistance covered under EPAct to assure appropriate intellectual property provisions.

(2) Cost sharing requirement. Financial assistance applications must show the requisite cost sharing commitment. The following is suggested language which could be included in solicitations.

Cost Sharing Requirement

> EPACT 3002 requires a cost sharing commitment of 20 percent from non-Federal sources for research and development projects. For demonstration or commercial application projects, the cost sharing requirement from non-Federal sources is 50 percent. Your application budget must show the breakout between Federal and non-Federal sources and how you propose to meet the cost sharing requirement. The non-Federal share may include cash, personnel, services, equipment, and other resources.
>
> All cost sharing or matching contributions, including cash and third party in-kind, shall meet the following criteria:
>
> (1) are verifiable from the recipient's records,
>
> (2) are not included as contributions for any other federally-assisted project or program,
>
> (3) are necessary and reasonable for proper and efficient accomplishment of project or program objectives,
>
> (4) are allowable under the applicable cost principles,
>
> (5) are not paid by the Federal Government under another award, except where authorized by Federal statute to be used for cost sharing or matching.
>
> Values for recipient contributions of services and property shall be established in accordance with applicable cost principles.
>
> Volunteer services furnished by professional and technical personnel, consultants, and other skilled and unskilled labor may be counted as cost sharing or matching if the service is an integral and necessary part of an approved project or program. Rates for volunteer services shall be consistent with those paid for similar work in the recipient's organization. In those instances in which the required skills are not found in the recipient organization, rates shall be consistent with those paid for similar work in the labor market in which the recipient competes for the kind of services involved.

Additional guidance regarding cost sharing or matching provisions is contained in 10 CFR 600.123 and 10 CFR 600.224 for financial assistance recipients.

In addition to including the appropriate information in solicitations, the contracting officer must also ensure that the award document incorporates the cost sharing requirement and the cost sharing is obtained.

C. Waiver of cost sharing requirement.

The Secretary has delegated the authority to make the determinations waiving the section 3002 non-Federal cost sharing requirement to the Deputy Assistant Secretary for Procurement and Assistance Management. The Deputy Assistant Secretary for Procurement and Assistance Management, by separate document, redelegated authority to make EPAct cost sharing determinations to the Heads of Contracting Activities (HCAs) and, with respect to the financial assistance under the Office of Energy Research Program Rule, 10 CFR Part 605, to the Director, Office of Energy Research.

Any determination waiving or reducing a cost sharing requirement must be based on the section 3002 criteria. For research and development programs, the DOE must determine that the research and development is of a basic or fundamental nature.

For demonstration and commercial application programs, the determination must show that the reduction is necessary and appropriate considering the technological risks involved in the project and the project is necessary to meet the objectives of EPAct. This determination should be based on demonstrated results of activities such as the following:

(1) solicitations. The contracting activity has attempted to obtain cost sharing, but industry and others did not respond to the solicitation.

(2) other studies. Market surveys or other studies have been conducted which provide significant data that commercial organizations are not willing to participate in the financial assistance program or other activity because of the cost sharing requirements.

IV. Effective Date. This Financial Assistance Letter is effective upon issuance.

V. Expiration Date. This Financial Assistance Letter will remain in effect until cancelled.

VI. Covered Programs. The attached listing identifies EPAct covered programs.

FAL 96-01 (3/08/96)
Attachment

COVERED PROGRAMS- § 3002	EPACT SECTIONS
Fossil Energy R & D	
Coal *All Programs Including*	§ 1301-1312
Coal-fired Diesel Engines	§ 1302
Clean Coal, Waste-To-Energy	§ 1303
Nonfuel Use of Coal	§ 1304
Coal Refinery Program	§ 1305
Coalbed Methane Recovery	§ 1306
Metallurgical Coal Development	§ 1307
Utilization of Coal Wastes	§ 1308
Underground Coal Gasification	§ 1309
Low-rank Coal Research and Development	§ 1310
Magnetohydrodynamics	§ 1311
Oil Substitution Through Coal Liquefaction	§ 1312
Clean Coal Technology	§ 1321

COVERED PROGRAMS - § 3002	EPACT SECTIONS
Fossil Energy R & D	
Petroleum	
Enhanced Oil Recovery All Programs Including:	§ 2011
Heavy Oil	§ 2011
Light Oil	§ 2011
Tar Sands	§ 2011
Advanced Extraction & Process Tech All Programs Including:	§ 2011
Geological Science/Extract Research	§ 2011
SPT Technology/Environmental Research	§ 2011
University Geoscience Research	§ 2011
Oil Shale All Programs:	§ 2012
Gas	
Natural Gas Research All Programs Including:	§ 2013-2015
Resource & Extraction	§ 2013, 2014
Delivery & Storage	§ 2013, 2014
Utilization	§ 2013, 2014
Environmental Research & Regulatory Analysis	§ 2013, 2014
Midcontinent Energy Research Center*	§ 2013, 2015
Fuel Cells All Programs Including:	§ 2115
Advanced Research	§ 2115
Phosphoric Acid Systems	§ 2115
Molten Carbonate Systems	§ 2115
Advanced Concepts	§ 2115
Energy Conservation	
Transportation All Programs Including:	**§ 2021-2025, 2027, 2028, 2112**
Alternative Fuels Utilization	**§ 2021, 2023**
Materials Development	**§ 2021**
Heat Engine Development	**§ 2021, 2112**
Electric & Hybrid Propulsion Development	**§ 2021, 2025**
Implementation & Deployment	**§ 2021**
Management	**§ 2021**

Management-Capital Equipment	§ 2021
Advanced Automotive Fuel Economy	§ 2021, 2022
*Biofuels User Facility**	§ 2021, 2024
*Advanced Diesel Emissions Program**	§ 2021, 2027
*Telecommuting Study**	§ 2021, 2028
Utility All Programs Including:	§ 2101
Integrated Resource Planning	§ 2101
Program Direction-IRP	§ 2101
Energy Management Control	§ 2101
Industry All Programs Including:	§ 2101-2108
Industrial Wastes	§ 2101
Municipal Solid Wastes	§ 2101
Cogeneration	§ 2101
Electric Drives	§ 2101, 2105
Materials Processing	§ 2101, 2107
Separations	§ 2101
Sensors & Controls	§ 2101
Bioprocessing	§ 2101
Enabling Materials	§ 2101
Improved Combustion Efficiency	§ 2101, 2107
Process Heating & Cooling	§ 2101, 2102
Implementation & Deployment	§ 2101
Management	§ 2101
Management-Capital Equipment	§ 2101
*National Advanced Manufacturing Tech Initiative**	§ 2101, 2202
*Pulp & Paper**	§ 2101, 2103
*Steel, Aluminum, and Metal Research**	§ 2101, 2106
*Energy Efficient Environmental Program**	§ 2101, 2108
Buildings All Programs Including:	§ 2101-2108
Solar Technologies	§ 2101
Materials & Structures	§ 2101
Lighting & Appliances	§ 2101
Heating & Cooling Equipment	§ 2101, 2102
Indoor Air Quality	§ 2101
Building Systems Research	§ 2101
Federal Energy Management Program	§ 2101
Implementation & Deployment	§ 2101
Management	§ 2101
Management-Capital Equipment	§ 2101

*Advanced Buildings for 2005**	§ 2101, 2104
Energy Supply R & D	
Energy Research	
Fusion Energy All Programs Including:	§ 2114
Confinement Systems	§ 2114
Development & Technology	§ 2114
Applied Plasma Physics	§ 2114
Planning & Projects	§ 2114
Inertial Fusion Energy	§ 2114
Program Direction-Op Exp	§ 2114
Capital Equipment & Construction	§ 2114
Basic Energy Sciences All Programs Including:	§ 2203
Materials Sciences	§ 2203.
Chemical Sciences	§ 2203
Energy Biosciences	§ 2203
Engineering & Geosciences	§ 2203
Applied Math Sciences	§ 2203, 2204
Advanced Energy Projects	§ 2203
Advanced Neutron Source	§ 2203
Program Direction	§ 2203
Capital Equipment	§ 2203
Advisory & Oversight/Program Direction	§ 2203
Energy Research Analysis	§ 2203
University & Science Education Programs	§ 2203
*Experimental Program to Stimulate Competitive Research**	§ 2203
Laboratory Technology Transfer	§ 2203
Multi-Program Laboratory Support	§ 2203
Nuclear Energy	
Light Water Reactor	§ 2123, 2126
Advanced Reactor R&D	§ 2121, 2122 2124, 2126
Facilities	§ 2126
Solar & Renewables	
Solar & Other Energy All Programs Including:	§ 2021, 2026, § 2111, 2117
Photovoltaics	§ 2111
Biofuels	§ 2021
Solar Technology Transfer	§ 2111
NREL	§ 2111

Program Direction- Other Solar Energy	§ 2111
Solar Building Technology Research	§ 2111
Solar Thermal Energy Systems	§ 2111
Wind Energy Systems	§ 2111
Ocean Energy System	§ 2111
International Solar Energy Program	§ 2111
Resource Assessment	§ 2111
Program Support	§ 2111
Geothermal	§ 2111
Hydrogen Research	§ 2026
Electric Energy Systems including: Superconductivity	§ 2117, 2111
Energy Storage Systems	§ 2111
Environmental Restoration & Waste Management	
Facility Transition-Fast Flux Test Facility	§ 2116
Civilian Waste R & D	§ 2113
Electric & Magnetic Fields Research and Public Dissemination Program*	§ 2118
Spark M. Matsunga Renewable Energy & Ocean Technology Center*	§ 2111, 2119

*Direct citation from Title XX-XXIII.

Q8b. EPACT was signed into law on October 24, 1992. Why did it take the Department nearly 3 ½ years to issue final guidance?

A8b. A8b. From the time EPACT was signed into law in October 1992 until the final guidance was issued in 1996, many issues were raised with respect to the interpretation of certain parts of Section 2306 and the way it should be implemented. During this time period DOE prepared Financial Assistance Letter 94-1R (September 1994) and 10 CFR 600, each of which provided guidance on implementation of Section 2306. Throughout this time DOE always updated its current implementation guidance and procedures as a result of the lessons being continuously learned in each new Section 2306 determination.

In April of 1994 DOE prepared a proposed schedule for rulemaking in order to implement Section 2306 of EPACT which set forth milestone dates beginning with initial drafting on April 20, 1994, and ending with publication of the final rule on March 17, 1995. In May 1994 DOE determined to accelerate the rulemaking by utilizing the "reengineered" process and proposed September 1994 as the time frame for publishing the final rule. However, as the rulemaking progressed, many issues were raised by various interested parties. These issues included who was to be included as "companies" that could participate, how to treat teams of participants, treatment of participants whose status changed during the term of the award, how did the North American Free Trade Agreement affect implementation of Section 2306, and how was Section 2306 to be implemented with respect to the Small Business Innovation Research and Small Business Technology Transfer programs. As a result of these and other issues, the final rule wasn't published until February 23, 1995.

Although the final guidance provided by Acquisition Letter 96-04 and Financial Assistance Letter 96-01 was not finalized until 3½ years after EPACT was signed into law, it reflects DOE's deliberate process of adequately addressing all the unique issues that arose during this time period.

Q9. The following question was submitted by Congressman Steve Schiff, Chairman of the Basic Research Subcommittee:

> **"It is my understanding that licensing arrangements entered into by DOE laboratories and industry for the purpose of commercializing technology developed at the labs permit the companies involved to insist that the licensing fees and royalties be kept secret. I have been told that royalty arrangements are kept private to protect sensitive business information that might be inferred from the rate and time established by an arrangement.**
>
> **"Is it necessary, as some maintain, to keep this information private in order to ensure that the government will be able to continue to attract industry to these programs? What information from licensing arrangements must be released? What is the difference between the information that must be made public and that which can remain secret? How does the government ensure that taxpayers are receiving a return on their investment**

when private sector partners choose to exercise their 'right' to keep information from being divulged?"

A9. DOE has been sensitive to its laboratory contractors' contentions that licensing and royalty information should be kept confidential in order to make laboratory licensing programs attractive to industry. The laboratories generally do annually provide, for public release, information on the numbers of licenses and aggregate royalties received in a particular year. DOE generally concurs with the laboratories that public release of specific licensing information such as royalties from a license, royalty rate, royalty base, sales of licensed product and name of licensee should not be made public by the Government since it would likely discourage some companies from laboratory licensing programs based on concerns that their sensitive business information may be unfairly available to competitors. Government oversight over laboratory technology transfer activities is generally accomplished through its right to review and audit this information at the laboratory, and, in potential conflict of interest situations, to pre-approve the license, without the necessity of these records being potentially publicly available. Since the technology arose under Laboratory mission research, taxpayers have received a return on their investment by virtue of the mission-related research. Any royalties received by the laboratories amount to an added benefit.

The following questions were submitted by Congressman Tom Roemer, Ranking Democratic Member, Subcommittee on Energy and Environment:

Q10. Broadly speaking, what costs could be included in the calculation of the amount to be recouped in a recoupment agreement? For instance, when the University of New Mexico looked at the costs involved with two technology transfer activities at Sandia National Laboratories, they found that the direct costs, through the technology transfer grant, were relatively small when compared with the total cost of the technology transfer activity, which included the labor costs of Sandia personnel. Are their precedents concerning the inclusion or exclusion of labor costs in either public or private sector recoupment agreements?

A10. Whatever the contractual agreement (whether or not involving any form of recoupment), the Department of Energy's pricing requirements are set forth at 10 CFR, Part 1009, "General Policy for Pricing and Charging for Materials and Services Sold by DOE." In establishing the basis for DOE or laboratory cost, Part 1009 provides that direct and allowable costs may include, but are not limited to, the following cost elements:

1. Direct labor;

2. Personnel fringe benefits;

3. Direct materials and other direct costs;

4. Overhead costs, such as maintenance and utilities;

5. General administrative costs (of DOE's management and operating contractor), such as legal or procurement;

6. Depreciation costs covering facilities and equipment; and

7. Departmental added factor (overhead), which includes costs incurred by DOE for the administration and direction of the DOE work for others program.

Q11. Industry representatives sometimes state that recoupment agreements can harm the competitiveness of American companies abroad. What would be the process of determining whether such a claim were true, especially in the relatively simple case of a specific company with a specific product.

A11. There is no specifically defined departmental process; such decisions would be made on a case by case basis involving Departmental experts from the program sponsoring the work.

Q12. According to the GAO, one of the problems that DOE has had recently in administering recoupment agreements is the development of a sound accounting system to determine the amount and schedule on which recoupment payments should be made. What components should compromise such a system and what are the major obstacles to developing a sound system?

A12. The Office of CFO has committed to developing appropriate financial policies and procedures over Departmental recoupment activities for issuance by January 31, 1997. Guidance in the future should encompass royalties and return on investment activities. In developing the financial guidance on recoupment activities, the Office of Chief Financial Officer intends to work with appropriate elements of the Department and with OMB. During the development process, relevant components of such a system will be identified and included as appropriate. Initial ideas as to what may comprise such a system are as follows: (1) departmental financial policy statement to include designation of responsibilities for various functions; (2) establishment of accounts for deposit and recording of recoupments collected; (3) program determination of how collections will be used in accordance with applicable statutes; (4) program establishment of mechanism for monitoring progress of work under agreements to ensure awareness of events that trigger repayments due; and (5) cooperation among the various program and support offices,(e.g., finance and procurement offices) to ensure appropriate actions in a timely fashion (e.g., prior to initiation of agreements with recoupment provisions, programs need to communicate with cognizant procurement offices in establishing terms of agreements, including designation of costs to be recouped). During the performance stage of agreements, programs need to interface with cognizant finance offices to initiate timely billing and collection procedures as well as appropriate budgetary treatment of recoupments received and anticipated. One major obstacle in developing a sound system is that it's impossible for the programs to know with absolute certainty (without 100% audit which would be costly and perhaps not cost-effective) what projects are eligible for recoupment in terms of being commercially successful.

Q13. How has the signing of GATT (with its strict cost-sharing requirements for federal R&D) affected DOE's cost-sharing practices?

A13. Article 8 of the World Trade Organization Agreement on Subsidies and Countervailing Measures provides that research and development subsidies are non-actionable if they meet the criteria specified in Article 8. A WTO member country has no right to impose countervailing measures, or to seek remedies under the Agreement's dispute settlement mechanism, with respect to non-actionable subsidies. All subsidies that are not specific, or not deemed to be specific, within the meaning of the Agreement, are non-actionable. In addition, assistance for research activities by firms, higher education establishments, or research establishments on a contract basis are non-actionable if the assistance covers no more than 75 percent of industrial research costs or 50 percent of pre-competitive development activity.

It has not been determined that any DOE research and development program constitutes an actionable study. The United States has reported DOE programs to the WTO Subsidies Committee in the United States' general notification of U.S. Government programs, subject to a proviso that the notification does not mean that any particular program constitutes a subsidy, or a subsidy specific to any particular industry or region. Although DOE did not report any of its subsidies as "non-actionable" under Article 8, DOE believes that all of its subsidies are non-actionable. Therefore, DOE has not found it necessary to change its funding policies, which thus far, are unchallenged by WTO member countries.

DOE's contribution to the United States' notification indicated the government's share of costs under each program. We are not aware of any program which provides more than 75 percent of industrial research costs or more than 50 percent of the costs of pre-competitive development activity.

Q14. The DOE IG has questioned the accounting of in-kind contributions on some CRADAs. What is the status of these inquiries and will DOE institute stricter accountability requirements for in-kind contributions as a result of these investigations?

A14. The perspective of the IG, that partners who receive no Federal funds should be subjected to audits, has been rejected as overzealous, unnecessary and counterproductive by the Department's leadership. The Department and its laboratories have a process, which is based on how in-kind contributions are evaluated under procurements, for validating the value of the partner's contributions. The laboratories and facilities perform the validation and the Operations Offices, as part of their oversight activities, ensure that the laboratories and facilities are diligent in the performance of these validations. The Department has taken the position that what is important are the outcomes of the joint efforts. If the Department found a way to deliver the scientific and technical results from its portion of the research faster and for less cost than originally estimated, the partner would not request that the Department expend the planned level of effort, nor should the taxpayer go through the expense of such an audit when what is at issue is the effective use of the private party's funds, not the taxpayers. Our partners have indicated that they would find such audits (or inspections or evaluations) costly and intrusive to the point of making the proposed relationship not worth the trouble. Our goals are to deliver research results against our mission priorities while making the partnership reasonably attractive to our partners as provided for, and encouraged, by statute. The suggested audit approach flies in the face of such Congressional guidance and program management best practices.

The Department does not have a formally established goal for in-kind contributions, although some specific activities, such as Defense Programs Technology Transfer Initiative, at various times has indicated an expectation that the division would be fifty-fifty. The DOE did not establish such a Department-wide expectation for several reasons. First, it was not clear that one size fit all, and that in terms of basic research the risk might be greater, making a greater Federal contribution more reasonable, and in applied research the reduced risk might lead to greater partner contributions. This in fact turned out to generally be the case. Additionally, there was a concern that small businesses might not be able to "match" contributions but could contribute nonetheless in ways that had programmatic benefits. Furthermore, in some cases there were several laboratories and several partners involved and the accounting to demonstrate 50%-50% would have been complex, costly, and not add to the likely success of the project. Most importantly, as a matter of principle, the relationship was deemed to be driven by the nature of the project and then the criterion was "were the proposed contributions reasonable." The statutory guidance for CRADAs was silent on the division but was clear on the desire to get effective leveraging encouraged. The Department therefore had no formal expectations for the division but did monitor through the CRADA Information Management System and its successor, the Integrated Technology Transfer System, the division of investment in several categories (by technology, program, laboratory, etc.) in order to identify anomalies. The expectations are communicated primarily as part of the negotiation process, but when there is a specific programmatic criteria that would also be communicated as part of any preliminary programmatic announcements and associated programmatic information. What information DOE does obtain on the partner's in-kind contribution is initially developed as part of the negotiation process. The laboratory determines whether the valuation is reasonable. There are periodic project reviews where the technical progress is evaluated and it is possible that issues of the timeliness and extent of provision of planned in-kind contributions could be addressed–but in the programmatic context and not as a separate issue. Once the level of effort for each party is determined the focus is then on accomplishing the task. Our partners typically do not seek to audit the laboratories expenditures or we their's. Outcomes of projects are evaluated by those involved in the project and may also be evaluated either separately or as part of a series of activities within the laboratories, by the Operations Office and by the funding program or programs. Often the project fits into a larger program activity at a laboratory and is reviewed as part of the broader effort

Mr. Allen Li
Associate Director
Energy, Resources, and Science Issues
Resources, Community, and Economic Development Division
U.S. General Accounting Office

Followup Questions and Answers

GAO'S RESPONSE TO SUBCOMMITTEE'S QUESTIONS

Question 1:

Your report shows a wide variance of repayment programs, and none at all in the case of programs such as the Advanced Turbine Program. Did you find any rationale for some programs having repayment provisions and others none?

GAO's Response:

As our report points out,[1] DOE does not have a Department policy for recovering its investment in technology development programs and projects, and as a result, we could not find agency rationale for why some cost-shared programs have a repayment requirement and most do not. Although DOE considered having such a policy in 1991 and even developed a draft order with criteria and guidelines for determining when repayment is appropriate, the order was never implemented.

We did find that in the four programs that require repayment for technologies that are successfully commercialized, the Congress encouraged or required repayment. As our report points out, appropriations laws require repayment for projects in the Metals Initiative Program. Repayment is recommended in appropriations reports for the Electric Vehicles Advanced Battery Program and for a portion of additional funding provided under a specific contract in the Advanced Light Water Reactor Program. (DOE also decided to require repayment for two other projects under a cooperative agreement in the Advanced Reactor Program.) DOE made a programmatic decision, in consultation with the Congress and industry, to require repayment for projects in the Clean Coal Technology Program.

DOE's national laboratories and energy research centers can also receive royalties and fees from licensing patents for inventions, processes, and services that the laboratories and centers develop, or that are developed under CRADAs and other mechanisms. Although the provisions covering these agreements can constitute a form of repayment, they are designed to provide the government with a way to share in the success of a technology and are independent of the government's contribution to the underlying technology.

Question 2:

If the Congress wanted to make sure that recovered funds were plowed back into the program, what would be the best mechanism?

---

[1] Energy Research: Opportunities Exist to Recover Federal Investment in Technology Development Projects (GAO/RCED-96-141, June 26, 1996).

GAO's Response:

During our review many DOE officials indicated that any proceeds from repayment programs should flow back into the program to leverage the federal funding that would be available for ongoing and future projects, rather than be deposited in the Treasury. Without additional work, we are unable to provide a definitive answer to the best mechanism to use because it was beyond the scope of our work concerning the recovering of the federal investment in technology development projects. However, based on prior work, we have the following observations.

During 1996, we testified on concession reform on federal lands and issued several reports on concessions operations in the federal government. Our work has shown that retaining fees for use in agencies' operations serves as a powerful incentive in managing concessions. Our May 1996 report on concessions contracting in the Department of Defense's three military exchange services showed that a key factor increasing the exchange services' rate of return was the agencies' authority to retain concession fees.[2] Our April 1996 report on concessions operations in civilian agencies throughout the federal government also indicated that when agencies are authorized to retain most of their concession fees, the return to the government is significantly higher.[3] In addition, our past work in the Park Service and Forest Service has indicated that retaining additional financial resources through fees--including entrance fees, user fees, and concession fees--will provide some assistance to parks, forests, and other recreational areas across the nation to meet a backlog of several billion dollars of unmet maintenance and infrastructure needs.

However, permitting agencies to retain a portion of the fees from concessioners has a number of tradeoffs. If the Congress decides to use increased fees to supplant rather than supplement existing appropriations, this incentive could be significantly reduced. Our July 1996 testimony noted that permitting the land management agencies to retain fees is a form of "backdoor" spending authority, and as such raises questions of oversight and accountability.[4] In addition, earmarking revenues reduces governmentwide budgetary flexibility as the activities targeted to receive the funds do not compete for them against other potential uses. Also, concessions and most other activities that generate fees from the public are of a continuing nature and can be predicted, whereas repayments from research and development projects would not likely provide a steady stream of budgetary resources. Repayments would also be less certain because they would depend on whether the federal contribution results in a marketable product. Finally, it may not be desirable to allow funds to flow back to programs that are scheduled to be terminated at some point in the future.

---

[2] Concessions Contracting: DOD Military Exchange Services' Rates of Return (GAO/GGD-96-108, May 9, 1996).

[3] Concessions Contracting: Governmentwide Rates of Return (GAO/GGD-96-86, Apr. 29, 1996).

[4] Federal Lands: Concession Reform is Needed (GAO/T-RCED/GGD-96-223, July 18, 1996).

Question 3:

You recommend a grace period after a project ends before repayment begins. Is this common practice in the private sector?

GAO's Response:

Our report noted that one way to mitigate DOE's concern about the effect of repayment on the ability of the entity carrying out the project to compete in the marketplace could be to allow a grace period after a project ends before requiring repayment to begin. Our work did not address industrywide practices with respect to repayment and grace periods. However, from our discussions with DOE officials and some project participants involved in the DOE programs that require repayment, we obtained the following information with respect to private sector grace periods.

In the Electric Vehicles Advanced Battery Program, the Advanced Battery Consortium requires repayment of its investment in six of its eight subcontracts with battery developers. However, the consortium allows a grace period before repayment begins in only one of its subcontracts.

In the Advanced Light Water Reactor Program, the Advanced Reactor Corporation requires repayment of its investment in two first-of-a kind engineering projects being conducted under separate subcontracts with General Electric and Westinghouse. According to DOE program officials, the two subcontractors are required to pay the Advanced Reactor Corporation a royalty on all commercial sales or licensing of the technologies over a 20-year period. We were told that there is no grace period.

A state official whose office provides cost-share funding for projects that develop cleaner, more efficient, and less expensive coal technologies, including some projects in DOE's Clean Coal Technology Program, told us that her office generally requires repayment with no grace period if the technologies are commercialized. However, the state official said that her office has provided a grace period in rare instances to allow a small company to make its first three commercial sales into the marketplace before beginning repayment.

The following questions were submitted by Congressman Steve Schiff, Chairman of the Basic Research Subcommittee.

"It is my understanding that licensing arrangements entered into by DOE laboratories and industry for the purpose of commercializing technology developed at the labs permit the companies involved to insist that the licensing fees and royalties be kept secret. I have been told that royalty arrangements are kept private to protect sensitive business information that might be inferred from the rate and time established by an arrangement."

Question 4.a:

Is it necessary, as some maintain, to keep this information private in order to ensure that the government will be able to continue to attract industry to these programs?

GAO's Response:

In prior work, technology licensing officers whom we interviewed at both universities and federal laboratories have similarly told us that potential licensees prefer that terms of a licensing agreement not be made public. However, we have not independently surveyed businesses to determine whether nondisclosure is a necessary precondition for negotiating and signing a technology licensing agreement.

Question 4.b and c:

What information from licensing agreements must be released? What is the difference between the information that must be made public and that which can remain secret?

GAO's Response:

DOE patent attorneys told us that DOE requires its laboratories to provide aggregate information annually about their technology licensing activities. Such information would include the number of technology licenses granted and license income, including royalties, received.

The Freedom of Information Act (5 U.S.C. 552) establishes requirements for disclosure of government records to the public. The act specifically excludes certain records from disclosure. In particular, 5 U.S.C. 552(b)(4) excludes "trade secrets and commercial or financial information obtained from a person and privileged or confidential."

On June 24, 1996, DOE published a Notice of Proposed Rulemaking in the Federal Register entitled Acquisition Regulation; DOE Management and Operating Contracts to standardize requirements for its government-owned, contractor-operated (GOCO) laboratory contractors. The proposed regulation addresses ownership of records in 48 C.F.R. Part 970.5204. Except for certain enumerated exceptions, the proposed rule states, "all records acquired or generated by the contractor in its performance of this contract shall be the property of the Government and shall be delivered to the Government..." The DOE section-by-section analysis states that this ownership provision would grant public access to these records. However, one of the enumerated exceptions to government ownership is "records maintained pursuant to the technology transfer clause of this contract," including "(i) executed licensing agreements; (ii) the contractor's protected CRADA information and appendices to a CRADA that contain licensing terms and conditions or royalty or royalty rate information; and (iii) patent, copyright, mask work, and trademark application files and related contractor invention disclosures, documents and correspondence, where the contractor has elected rights or has permission to assert rights and has not relinquished such rights or turned such rights over to the Government." These records would be considered the property of the contractor.

The proposed regulation also states that all records acquired or generated by the contractor are subject to inspection, copying, and audit by the government or its designee. Furthermore, copies of any of the contractor's own records, including technology transfer agreements, shall be delivered to DOE or its designee in the event of completion or termination of the contract.

Question 4.d:

How does the government ensure that taxpayers are receiving a return on their investment when private sector partners choose to exercise their "right" to keep information from being divulged?

GAO's Response:

A federal laboratory's technology licensing office has primary responsibility to negotiate licensing agreements, ensure the licensee exercises due diligence in commercializing the technology, and ensure that the licensee makes timely and appropriate royalty payments. DOE also has included a clause in at least some of its management and operating contracts for its GOCO laboratories that requires the contractor to obtain the approval of DOE's contracting officer prior to any assignment, exclusive licensing, or option for exclusive licensing of intellectual property to (1) any person who currently is, or within the preceding 2 years had been, a contractor/laboratory employee and/or consultant or (2) a company in which such a person is a principal. In addition, DOE and GAO have access to any associated GOCO laboratory records for audit purposes.

The statutes that authorize federal laboratories to negotiate patent licenses and CRADAs stipulate how any resulting royalty income may be used. The Bayh-Dole Act (35 U.S.C. 202(c)(7)(E)) stipulates that a subject GOCO facility shall use any license income remaining after royalty payments to the inventor(s) and associated licensing expenses for research, development, and education. However, the facility must pay to the U.S. Treasury 75 percent of any royalty income remaining after expenses if this income exceeds 5 percent of its annual budget. The Federal Technology Transfer Act (15 U.S.C. 3710a(b)) similarly stipulates how GOCO laboratories may use any resulting CRADA income. The royalty-sharing provisions of both acts were designed to encourage federal laboratory scientists and managers to transfer technology to U.S. businesses by distributing any resulting income primarily to the inventor(s) and laboratory involved. In general, federal agencies have not paid royalty income to the U.S. Treasury, except in cases of administrative oversight when monies were not distributed within specified time frames.

Mr. Gregory H. Friedman
Deputy Inspector General for Audits
U.S. Department of Energy

Followup Questions and Answers

HEARING OF THE SUBCOMMITTEE ON ENERGY AND ENVIRONMENT
COMMITTEE ON SCIENCE
U.S. HOUSE OF REPRESENTATIVES

on

Funding Department of Energy Research and Development
in a Constrained Budget Environment

Thursday, August 1, 1996

Followup Questions Submitted to

Mr. Gregory H. Friedman
Deputy Inspector General for Audits
U.S. Department of Energy

Q1. You outline how changes in the Clean Coal Technology (CCT) Program cost the taxpayers about $133 million. Since the program has been going on for ten years, can you tell us when and how these decisions were made?

A1. The following table demonstrates what decisions, based on Program Opportunity Notices (PON) or negotiations, were made regarding the $133 million:

DECISIONS	AMOUNT	WHEN	HOW
Exemption of Foreign Sales	$120.3M	1989 & 1990	As a result of contract negotiations and exclusion from PON issued in 1989.
Exclusion of Some Domestic Sales	$12.7M	1988 & 1989	As a result of contract negotiations.
Lower Repayment Rates	$0.7M	1990	As a result of lowered repayment rate set by PON issued in 1980.
TOTAL	$133.7M		

Q2. You say that most of the cost-shared CRADA projects do not involve actual cash.

Q2a. Could you please elaborate on this point, and did you examine how monetary values are put on in-kind contributions?

A2a. The information available to us for the 210 CRADAs at the Sandia National Laboratories was that the Government's share of in-kind contributions was approximately $241 million. The majority of industry's $306 million contribution was in-kind ($272 million) while the cash portion of the contribution totaled approximately $34 million. We did not directly examine how values were put on in-kind contributions. We tried to determine how the Department validated the value the partner had placed on in-kind contributions and found that the Department had no mechanism to validate this information.

Q2b. Is it also true that the Federal cost-share is also in-kind?

A2b. Yes, it is also true that the Federal cost-share is in-kind. A CRADA is a cost-sharing agreement between the Government and a nonfederal entity. The Government contributes facilities, personnel, and equipment for its share.

Q3. You describe the problems with accurate valuations of partner contributions in the CRADA program. Is this the result of a lack of expertise in this area or a lack of interest in seeing it done?

A3. We sensed a reluctance on the part of the Department to validate partner in-kind contributions. Department management stated that partners would be hesitant to enter into CRADA arrangements if the Department's efforts to validate in-kind contributions were too intrusive.

Q4. You stated on page 3 of your prepared testimony that your audit "performed a detailed analysis for 6 [CCT] projects where recoupment decisions have affected the ability of the Department to recover taxpayers' investment." Please identify these 6 CCT projects.

A4. These 6 CCT projects were:

Nucla CFB Demonstration Project

Advanced Flue Gas Desulfurization Demonstration Project (Pure Air on the Lake)

Full-Scale Demonstration of Low-NOx Cell Burner Retrofit

LIFAC Sorbent Injection Desulfurization Demonstration Project

Evaluation of Gas Reburning and Low-NOx Burners on a Wall-Fired Boiler

ENCOAL Mild Coal Gasification Project

Q5. You stated on page 3 of your prepared testimony that "[t]he foreign sales exemption applies to an additional 19 clean coal projects that will be completed in the future." Please identify these 19 CCT projects.

A5. These 19 projects are:

Healy Clean Coal Project

Tampa Electric Integrated Gasification Combined-Cycle Project

PCFB Demonstration Project

Piñon Pine IGCC Power Project

Wabash River Coal Gasification Repowering Project

Warren Station Externally Fired Combined-Cycle Demonstration Project

Coal Diesel Combined-Cycle Project

Clean Energy Demonstration Project

Four Rivers Energy Modernization Project

10-MWe Demonstration of Gas Suspension Absorption

Confined Zone Dispersion Flue Gas Desulfurization Demonstration

Commercial Demonstration of the NOXSO S02/NOx Removal Flue Gas Cleanup System

Integrated Dry NOx/SO2 Emissions Control System

Milliken Clean Coal Technology Demonstration Project

Micronized Coal Reburning Demonstration for NOx Control

Commercial-Scale Demonstration of the Liquid-Phase Methanol (LPMEOH) Process

Self-Scrubbing Coal: An Integrated Approach to Clean Air

Blast Furnace Granulated-Coal Injection System Demonstration Project

Demonstration of Pulse Combustion in an Application for Steam Gasification of Coal–(This project (ThermoChem) has been terminated)

Q6. You stated on page 5 of your prepared testimony that "[t]he Department's decision to exclude some domestic sales from its repayment agreements resulted in missed opportunities to recoup an estimated $12.7 million on two projects." Please identify these two CCT projects.

A6. The two projects involved with the $12.7 million were:

Nucla CFB Demonstration Project–$12.5 million

Advanced Flue Gas Desulfurization Demonstration Project (Pure Air on the Lake)–$200,000

Q7. The following question was submitted by Congressman Steve Schiff, Chairman of the Basic Research Subcommittee:

> **"It is my understanding that licensing arrangements entered into by DOE laboratories and industry for the purpose of commercializing technology developed at the labs permit the companies involved to insist that the licensing fees and royalties be kept secret. I have been told that royalty arrangements are kept private to protect sensitive business information that might be inferred from the rate and time established by an arrangement.**
>
> **"Is it necessary, as some maintain, to keep this information private in order to ensure that the government will be able to continue to attract industry to these programs? What information from licensing arrangements must be released? What is the difference between the information that must be made public and that which can remain secret? How does the government ensure that taxpayers are receiving a return on their investment when private sector partners choose to exercise their 'right' to keep information from being divulged?"**

A7. We have not specifically looked into the area of licensing arrangements. Therefore, we are unable to provide that information.

Dr. Danny L. Hartley
Vice President
Laboratory Development Division
Sandia National Laboratories

Followup Questions and Answers

Follow-up questions
Sandia National Laboratories
August 19, 1996

1. **In your written statement, you described the new technology developed with the Fisher-Barton Company. In the study of this project done by the University of New Mexico, their figures show an $8 million profit for this new product. I understand that, in this case, the company paid for its own employee to work at the lab, holding down the lab's cost. How common is this practice, and is this one way we can hold down the cost to the taxpayers?**

   This practice is quite common. When in the course of a Sandia/industry technology partnership it is necessary for industry personnel to work at Sandia, the industrial partner usually pays the employee's wages and living expenses. Sandia provides space for the person to work but otherwise there is no direct impact on cost to the taxpayer. However, there is an indirect benefit to the taxpayer through this type of arrangement, in that Sandia scientists and engineers learn through the technology partnership. The daily interaction with the industry employee on-site helps foster that two-way interaction.

2. **How does Sandia market its patents, and what is the role of the Technology Ventures Corporation in this process?**

   Sandia markets its patents in a variety of ways. Information about the patent is available through the Internet (via Sandia's Web site, http://www.sandia.gov), as well as through the Commerce Business Daily. We also publish through selected trade publications and use targeted mailings, conference exhibits, and firm visits.

   Technology Ventures Corporation's role is not to market the labs' intellectual property. Once intellectual property is licensed to a start-up business, TVC often plays a critical role in helping that business with its business plan, investor funding, and other business support.

3. **Please provide a copy of the UNM analysis of Sandia's technology transfer efforts with Fisher-Barton.**

   Enclosed ~~in mailed copy~~

4. **In his written testimony before the subcommittee, Deputy Inspector General Friedman referenced a December 30, 1994 IG report "Audit of Verification of Cooperative Research and Development Agreement Partner Funds-In-Kind Contributions at Sandia National Laboratories" that "disclosed that current practices were inadequate for verifying partner in-kind contributions. What, if any, actions has Sandia taken to address the findings of that IG report?**

   Although that report did not produce any recommendations, Sandia and the Department of Energy have instituted new procedures to address the concerns raised in the audit. Subsequent guidance from DOE's Chief Financial Officer stated that contractor officials are responsible for reviewing and validating participant-supplied data and documentation that support the valuation of the participant's in-kind contributions. To do this, Sandia is expected to use its experience and knowledge relating to the value of goods and services as well as use sound business judgment to *validate the participants' expressed value and determine whether the in-kind contribution is reasonable.*

The guidance also provides additional direction for establishing the values of real or personal property as well as other types of contributions, such as training. Sandia was tasked to ensure that a sufficient level of documentation is maintained to demonstrate that the valuation of a partner's in-kind contribution is reasonable.

Furthermore, the Department of Energy/Albuquerque Operations Office issues a Tech Transfer Handbook that defines in-kind contributions, delineates the types that may be considered, and establishes a valuation methodology to be used to validate participants' in-kind contributions. The Handbook requires that Sandia complete a certification for each CRADA that contains Participant in-kind contributions

FINAL

TECHNOLOGY TRANSFER IMPACT PROFILES

Interim Report #1 Prepared for Sandia National Laboratories
Contract #AM 3455

by

Santa Falcone
School of Public Administration
University of New Mexico
Albuquerque, NM 87131-1216
(505) 277-4934

November 1995

The views expressed here are the author's and do not necessarily reflect those of Sandia National Laboratories, the Department of Energy, the University of New Mexico or any other institution.

Table of Contents

PAGE

Acknowledgements

Executive Summary 1

Chapter 1: Project Overview 2

Chapter 2: Research Method 9

Chapter 3: Plasma spray technology transfer 27

Chapter 4: Polycrystalline drill bit technology transfer 47

Chapter 5: Impact Profile Evaluation 79

Appendix A 84

Table of Tables

	PAGE
Table 1: Technology Transfer Costs and Benefits	11
Table 2: Comparison of Project Cycle Phases and Types of Program Evaluation	12
Table 3: Thermal Spray Coating Processes	28
Table 4: Comparison of Workmen's Compensation Ratings	58
Table 5: Estimate of PDC Drill Bit Sales	70
Table 6: Estimate of Number of Oil Wells Drilled with PDC Bits	73
Table 7: Published Cost Savings on PDC Bits Used in Territorial U.S.	74

Table of Figures

PAGE

Figure 1: Technology Transfer Model 16

Figure 2: Unit of Analysis: Technology Transfer Impact 17

Figure 3: Impact Profile 21

Figure 4: Impact Profile 22

Figure 5: Plasma Spray Diagram 30

Figure 6: Plasma Spray Impact Profile 45

Figure 7: PDC Cutter: Front and Side Views 48

Figure 8: Examples of PDC Drill Bits 48

Figure 9: Improvements in PDC Bits 1982-1986 52

Figure 10: Frequency of Lost Time Accidents 1963-1994 59

Figure 11: Frequency of Fatalities 1980-1994 59

Figure 12: PDC Impact Profile 77

Acknowledgements

Any new venture is a challenge. Challenges always include obstacles. Obstacles are opportunities disguised as termini. Phase I encountered many opportunities and the completion of this report celebrates that. This report profited from the written contributions of Maria Papadakis, Barry Bozeman, and Albert Link.

Today, the term "professional" is often a euphemism for rationalized self-interest. However, professional when used in reference to Glenn Kuswa, the Sandia National Laboratories official responsible for the oversight of this project, is as defined: having much experience in and great skill at, in this instance, scientific inquiry. Dr. Kuswa's high standards set the course of the project and enabled it to accomplish what many had asserted could not be done.

This research project prospected for information and there are many individuals, companies, associations, government agencies and institutions who were gold mines. Many desire to remain anonymous and will, yet their contribution is no less appreciated though not openly acknowledged. The 24 carat providers include but are not limited to: Jessica Glicken, David Glowka, Mark Smith, Dick Wilkey, Mahlon Dennis, Bill Lenling, the late Lou Hibbs, Craig Cooley, and Ken Tholan.

F. Lee Brown contributed encouragement, insight, ideas, direction, and freely shared his considerable experience and knowledge and, most precious, his time, throughout the project. Many thanks to all of the people who assisted in various capacities in un-disguising the opportunities including: Cathy Harter, Marie Falcone, Adelamar Alcantara, Larry Waldman, Brian McDonald, and Robin Morgan. Special thanks for computer use, graphics work, and mathematical assistance to Jacy Grannis. Thanks to all administrators including: Michael Buteri, Barbara West, Camille Pompeii, Sharon Sandoval, Diana Mendoza, and Kris Werblow. Thanks too to Chris Harmon for her forbearance and to Jacy and Jona Grannis for their patience.

Executive Summary

The *Technology Transfer Impact Profiles* project identifies the impacts of technologies transferred from Sandia National Laboratories to United States industry. The focus is the impact rather than other aspects of technology transfer. The impact includes economic effects and effects not readily quantifiable in dollar values. Since a sufficient length of time must elapse from when technology is transferred to when impact data is available, this project differs from many previous efforts in its retrospective nature. This report presents impact profiles for two targeted technology transfers: plasma spray and polycrystalline diamond drill bits.

The impact profiles indicate a positive outcome for both transfers. The cost-benefit ratios for both transfers compare favorably to the return expected by an investor in a high-technology venture of at least ten dollars for each dollar invested. In the plasma spray case, society, as the investor, received $190 for each dollar invested. In the polycrystalline diamond drill bit case, society received $180 for each dollar invested. In addition, the technology and health indicators demonstrate constructive contributions for both transfers.

Impact profiles provide a new, comprehensive, and useful mechanism to assess the impact of transferred technology. If impact profiles are applied more widely, they will also provide a documented record of the benefits received by the nation from research and development conducted at national and other government laboratories.

Chapter 1: Project Overview

The economic vitality of the United States is an objective of the federal government. Two gauges of economic vitality are national competitiveness and federal government indebtedness. National competitiveness refers to a nation's "... ability to produce goods that find demand in international markets while simultaneously maintaining, if not improving, the standard of living of its citizens"[1].

In the early 1980s, import penetration intensified leading to larger U.S. trade deficits. By 1985, several U.S. industries were suffering severe competitiveness distress[2]. More recently, the leadership of U.S. high-technology industries is being challenged at home and abroad[3]. High-technology industries are particularly important to the competitiveness crisis because they train scientific and engineering professionals through their proportionately larger amount of research and development (R&D) spending. In addition, they foster innovations that disperse into other economic sectors and provide the fuel for economic growth in all major industrialized countries[4].

The protracted inflation, recession, and, most particularly, the competitiveness crisis of the late 1970s and early 1980s refocused attention in the United States on the role of science and technology in enhancing economic welfare. Historically, spinoffs from defense research and development conducted by the national laboratories have generated technological innovations that have been used by domestic and foreign industries. Yet, political events in the late 1980s (democratization of the Eastern European countries, dissolution of the USSR, and perestroika) caused a shift away from federal defense expenditures in the early 1990s, thereby decreasing the potential for technological innovation from this source. At the same time, many industry groups have also decreased emphasis on research, further diminishing the potential for technological innovation.

---

[1] National Science Board, Science & Engineering Indicators-1993. Washington DC: U.S. Government Printing Office, (NSB 93-1) p. 158.

[2] Papadakis, M. (1994) "Did (or Does) the United States Have a Competitiveness Crisis?" *Journal of Policy Analysis and Management*. 13:1 1-20.

[3] National Science Board, Science & Engineering Indicators-1993. Washington DC: U.S. Government Printing Office, (NSB 93-1).

[4] National Science Board, Science & Engineering Indicators-1993. Washington DC: U.S. Government Printing Office, (NSB 93-1).

To increase the competitiveness of United States industry, the federal government has instituted programs to stimulate industrial R&D[5] (R&D tax credits beginning in 1981, Small Business Innovation Research Program of 1982, and National Cooperative Research Act of 1984). It has continued to spend a portion of its budget on R&D (4.5%)[6] and has established programs to transfer technology from government labs to United States industry (1980 Stevenson-Wydler Technology Innovation Act, Federal Technology Transfer Act of 1986, and National Competitiveness Technology Transfer Act of 1989). The cumulative result of many of these events is a strong stimulus to enhance the technological transfer capacity of the national laboratories.

Prior to these federal initiatives, the transfer of technology and innovation from the Department of Energy's ten national laboratories (Argonne, Brookhaven, Idaho National Engineering, Lawrence Berkeley, Lawrence Livermore, Los Alamos, National Renewable Energy, Oak Ridge, Pacific Northwest, and Sandia) to industry occurred but was usually incidental to the actual work of the Department of Energy (DOE). Offices for technology transfer were established within the laboratories in the 1980s in compliance with legislative mandate[7]. The combination of these government instituted programs and the end of the Cold War in 1991 broadened the orientation of DOE R&D, which had emphasized military technological superiority[8].

Reflecting this change in focus, the 1994 DOE Strategic Plan lists industrial competitiveness as the first of the five businesses of its scientific and engineering enterprise[9]. Accommodating this reorientation, technology transfer is one of four general components of the mission of Sandia National Laboratories[10]. In a recent report, the research and development budget allocations[11] of the national labs demonstrate this relatively recent focus[12]. The anticipated cumulative effect of these reorientations and initiatives is to foster U.S. economic vitality.

---

[5] ..."it is a truism that R&D bears a major responsibility for sustaining corporate earnings growth." (p. 20) Boer, F. (1994) "Linking R&D to Growth and Shareholder Value" *Research-Technology Management* 16-22.

[6] includes all (civilian and defense) R&D. Source: Department of Commerce (1995) "Table 9.7-Summary of Outlays for the Conduct of Research and Development : 1949-1996", Budget of United States Historical Tables. Posted on internet http:\\www.doc.gov\inquiry\BudgetFY96\BudgetFY96.html 245 pages.

[7] Stevenson-Wydler Technological Innovation Act of 1980.

[8] US Department of Energy, (1994) Fueling a Competitive Economy: Strategic Plan, April. and National Science Board, Science & Engineering Indicators-1993. Washington DC: U.S. Government Printing Office, (NSB 93-1).

[9] US Department of Energy, (1994) Fueling a Competitive Economy: Strategic Plan, April p. 6.

Excessive national debt, on the other hand, threatens U.S. economic vitality. It refers to the amount of money borrowed by the Treasury and by various federal agencies. In the United States, debt has been used to finance both the expense of modern warfare (from the 1900s to the present day)[13] and the increase in the quantity and cost of government-funded entitlements. The large, persistent deficits are increasingly sustained through reliance on foreign capital, making the national economy more vulnerable to action by foreign governments. As is shown below[14], the percent of the federal budget that is set aside to pay interest on the national debt, and is therefore not applied to productive use,

Year	National Debt	Net Interest	Total Outlays	Net Interest/ Total Outlays
1940	2,920	899	9,468	9.4%
1950	256,853	4,800	42,562	11.3%
1994	4,676,029	299,000	1,400,000	13.7%

(millions of dollars)

---

[10] Sandia National Laboratories Institutional Plan FY1995-2000. (SAND94-931) October 1994, p. 2-3.

[11] National Laboratories' Budget: Total:$7.5B; R&D:$3.8B; technical assistance:$0.556B(7% of total budget); technology transfer:$0.266B(3% of total budget) [source: see footnote #12]. The majority of technical assistance funds are allocated according to dual-benefit criteria.

[12] United States General Accounting Office (1994) "National Laboratories: Are Their R&D Activities Related to Commercial Product Development?" Washington DC: U.S. General Accounting Office. (GAO/PEMD-95-2) November.

[13] The perception of Congress and the public is that defense is an immense part of the budget. While defense is no longer a huge portion of the budget, it is one of the few programs open to the discretion of Congress and as such continues to sustain cuts. While allocations for defense operational readiness are maintained, defense research dollars are being cut. This will have consequences (probably unanticipated by Congress) both for future military readiness and the flow of spinoffs to industry.

[14] These budget figures are taken from Tables Nos. 504, 507, and 512 in the U.S. Bureau of Census. (1994) Statistical Abstract of the U.S.: 1994 114th edition. Washington DC. and from Table 5.1 in the Budget of the U.S. Government Historical Tables, Fiscal Year 1995. (1994) Washington DC: U.S. Government Printing Office p. 75.

has steadily increased, creating political pressure to balance the budget.

Despite these economically ominous challenges and although the percent of unencumbered revenues has decreased, the demand for public goods and services has steadily increased. The United States government has responded by expressing the intention to achieve more with fewer resources. To accomplish this, the federal government has begun to reduce its size and the amount of money it spends. It has also instituted programs, such as Total Quality Management and performance evaluation (Government Performance and Results Act of 1993 - GPRA), to enable the government to operate more efficiently and effectively with limited resources

GPRA has both positive and negative potential. On the positive side, performance evaluation can provide the information necessary to end, cutback, improve, or expand a program or organization. On the negative side, performance evaluation is costly, time-consuming, and its power can be harnessed through biased evaluation to achieve manipulated results. GPRA may be used in productive or unproductive ways according to the quality of the evaluations conducted and intentions of decisionmakers. Elements that influence the quality of evaluation include: the motives of the evaluators; what is measured; and the accuracy of the measurements. Effective, unbiased performance evaluation is difficult to achieve.

For the national labs, as for most public sector organizations and programs, evaluation subsequent to a change in direction can create the appearance of poor performance. Evidence of technology transfer (such as percent of the budget allocated to technology transfer or numbers of CRADAs[15]) and increased interaction with industry, while accumulating, may appear insignificant[16]. The primary use of R&D evaluation, as with most public-sector evaluation, is to reach a decision about a future course of action[17]. Moreover, while econometric studies confirm a positive relationship between private sector

---

[15] Cooperative Research and Development Agreement (CRADA)

[16] Evaluation that is conducted soon after a change (in organizational direction that supports technology transfer) may also not accurately measure and report the ultimate economic accomplishments of transferred technology.

[17] This is understandable and justifiable as part of the governmental or industrial research planning process. Research and development managers realize that their performance is measured by continued agency or corporate success. Success is achieved by wise spending of future dollars, planned for by using near-term [illegible]cs (including a combination of market research and cost-benefit analysis of potential pro[illegible]. Historical metrics, on the other hand, create a record that validates or refutes past decisions.

R&D and industrial productivity, linkages between public-sector R&D and industrial productivity are much more difficult to establish using traditional models.

New technologies, once introduced into the market, take time to have economic impact. In addition, in many industrial markets apportioning responsibility to each influence on commercialization is not an exact science, since many factors change simultaneously. Despite these limitations, it is important to attempt to identify the relationship between public sector R&D and industrial productivity to provide needed information about the actual long-term impact of public R&D investment.

Starting with examples from Sandia National Laboratories, this research project seeks to quantify the impact of the transfer of technology from the multiprogram national laboratories of the Department of Energy (DOE) to industry. The impact of the output of industrial research is difficult to quantify because the introduction to the marketplace and the economic return may take many years to develop. The quantification of the transfer of national laboratory research output is even more complex because the technology produced by the national laboratories may have diffused very broadly across various industries, requiring data to be gathered from many geographically dispersed locations. Regardless of the difficulty, however, the impact of these transfers of technology is important to quantify because the national laboratories' contribution has competitiveness consequences for the economy of the United States.

Anecdotal evidence has accumulated that the laboratories' resources have been both successfully and unsuccessfully applied to targeted technological development. Empirical evidence dealing with the outcome of the transfer of developed technology over a period of years has not been systematically compiled, however. This research project will attempt to estimate the overall impact of transferred technology. This includes the costs of the laboratories' programs and the economic benefits derived by domestic and foreign industries, through the transfers, from research and development at the laboratories.

To accomplish this task, a phased research project has been initiated. The objectives of the project phases are the following:

Phase I	- select multiple indicators to evaluate technology and obtain data for two technologies (plasma spray coating and polycrystalline diamond drill bits) transferred from Sandia National Laboratories (SNL)[14]

---

[14] Sandia National Laboratories was the first of the national laboratories to invest in this pilot study.

Phase II	- obtain data for a range of technologies transferred from SNL
Phase III	- obtain data for technologies transferred from other national laboratories
Phase IV	- obtain data for technologies transferred from other government agency laboratories.

These objectives will enable the national laboratories to quantitatively demonstrate the value of implementing the Department of Energy's mission: "In addition to defense[19], a comprehensive definition of national security includes energy security, environmental integrity, and *economic vitality* (emphasis added).[20]" To support economic vitality for example, a stated objective of Sandia National Laboratories is to "become a virtual corporate laboratory for major segments of U.S. industry" by establishing "a reputation for Sandia as industry's research lab of choice for the conduct of R&D that is reliable, relevant, timely, and *cost effective*[21]" (emphasis added). Another strategic objective is for "...its *economic impact* [to] be so tangible, that this activity becomes a line-item funded program in the future (emphasis added)[22]". The Galvin Panel or Task Force on Alternative Futures for the

---

[19] Project Y (Los Alamos Scientific Laboratory - LASL) came into existence in April of 1943 to develop the atomic bomb. An ordnance (military weapon) unit (E Division) was quickly established (June 1943) to produce a working weapon using known and unfolding theoretical knowledge. Six days after the Japanese accepted the Allied peace terms, LASL announced that within E Division a new organization (Z Division) would have responsibility for the atomic weapon stockpile. As Z Division came into existence, its mission was more clearly articulated to include atomic weapon assembly, testing, stockpiling, and surveillance. As part of a restructuring in 1948, Z Division was designated as a separate branch of LASL and renamed Sandia Laboratory. In 1949, the research directorate was created in concert with incorporation (Sandia Corporation) and a change in management (from the University of California to AT&T). This change established research and development as a priority structurally. In 1951, AT&T began a series of changes that increased the emphasis on research and development and decreased the on-site manufacture of weapons, reorienting Sandia Corporation from a "...production orientation to systems engineering based upon solid research". Furman, N. (1989) Sandia National Laboratories: the postwar decade. Albuquerque, NM: The University of New Mexico Press p. 683.

[20] Sandia National Laboratories Institutional Plan FY 1995-2000. SAND94-931 Oct 1994.

[21] SEAB (1994) "Visit of the Secretary of Energy Advisory Board (SEAB) Task Force on Alternative Futures for the DOE National Laboratories August 16, 1994", Sandia National Laboratories' Itinerary p. 7.

[22] (SEAB, 1994) p. 14.

Department of Energy National Laboratories recommended that the laboratories should develop and use outcome metrics to evaluate their technology transfer activities[23]. By quantifying the impact of transferred technology, SNL and other laboratories can make progress toward achievement of these objectives. These recommendations were made prior to the more recent Congressional questioning of the role of government in commercially useful R&D. This questioning increases rather than diminishes the importance and need for accurate evaluation to ensure that informed, effective, strategic decisions are made concerning reductions in government R&D expenditures.

The primary emphasis of Phase I of this research project is, therefore, to select indicators to assess the impact of technology transfers. This document reports the research project's Phase I findings in the following five sections: the project overview, the research method, the impact profile for the plasma spray transfer, the impact profile for the polycrystalline diamond drill bit transfer, and an evaluation of the impact profile method.

---

[23] Secretary of Energy Advisory Board (1995) "Alternative Futures for the Department of the Energy National Laboratories." Report by Galvin Panel. February.

Chapter 2: Research Method

A systematic method was developed for this research by considering: (1) the methods used prospectively in the private sector to evaluate the future potential of R&D investment; (2) public-sector project cycle and program evaluation; (3) indirect measures of the impact of R&D; and (4) the unit of analysis for this research. From this review, the indicators that will be used in this study to measure the impact of technology transfer were identified.

Private-Sector R&D Evaluation

There are three types of R&D evaluation used more frequently than others in the private sector: scoring models, financial appraisal models, and risk analyses[24]. Scoring models evaluate an R&D project against a list of criteria including "assessments of the attractiveness of the opportunity, its probability and risk for success, its match with company capabilities and business objectives, an estimate of the R&D investment required, and an assessment of competitive position"[25]. Financial appraisal models evaluate how the net present value of primarily product development programs contribute to the financial and strategic goals of industrial companies. Risk analysis methods combine statistical analysis and decision theory to rank R&D programs according to their anticipated profits. These methods are used to choose between R&D alternatives prior to the investment in R&D and are, therefore, influential. Occasionally, industry uses retrospective analysis of R&D, going back 15 or more years to estimate returns, but such results are usually available only within corporate circles because they contain proprietary information.

Within each of these three private-sector R&D evaluation models, the emphasis is on which research project optimizes specific criteria such as:

the best (engineering state of the art) technological result;
the greatest number of path-breaking findings;
the best achievement of a specific, predetermined technical performance standard
    (e.g., doubling energy usage efficiency); or
the most cost-effective approach.

---

[24] Sorenson, D., Nelson, K. and Tomsyck, J. (1994) "Industrial R&D Program Evaluation Techniques" *Evaluation Review* 18:1 February 52-64.

[25] Ibid. Sorenson, Nelson, and Tomsysck (1994) 54-55.

While science and engineering analysis is used for the first three criteria, the most cost-effective approach is determined using cost-benefit analysis[26]. In this approach, if the results and risks of several projects are similar, the research project that can be accomplished using the least resources is selected.

Because costs and benefits occur at different points in time, with costs often occurring before any benefits are realized, the costs and benefits are compared in present-value terms:

$$C/B \;=\; [\, \Sigma_{t=0\ \mathrm{to}\ n}\, C_t \,/\, (1+r)^t \,] \,/\, [\, \Sigma_{t=0\ \mathrm{to}\ n}\, B_t \,/\, (1+r)^t \,]$$

where C represents all tangible costs and B represents all tangible benefits, where the time frame over which costs are incurred and benefits are received is represented by t, and where the relevant rate of discount to equate future values to the present is represented by r.

For this study, the costs and benefits of each technology transfer[27] are calculated but are not compared to alternatives for a selection decision. The opportunity costs of the selected technology transfers were not included due to the basic assumption that DOE and SNL operate using procedures designed to select research opportunities with the highest return. The categories of technology transfer costs and benefits are capital, equipment, and labor (Table 1). In regard to society, these costs and benefits are part of the impact shown in the category "*economy*" (Table 1). Ideally, accurate dollar values would be obtained for each category. In actuality, the available information is not that "precise, certain, exhaustive, or unequivocal"[28]. Costs to conduct R&D may be more easily determined than benefits, since benefits accrue at different geographic locations, are usually received by more than one company, and occur at different points in time. The cost-benefit indicator for each technology in this study will, therefore, include only the items for which financial data are available.

---

[26] The internal rate of return calculation is defined as that rate i that makes the net present value (NPV) of a project equal to zero: NPV = $[(B_0-C_0)/(1+i)_0] + \ldots + [(B_n-C_n)/(1+i)_n]$. If the discount rate on costs is equal to the discount rate on benefits within a cost-benefit ratio, then when NPV=0, C/B=1. Both methods are valid, but cost-benefit analysis is used in this study.

[27] Technology transfer can be defined in several ways. Here it refers to the flow of information regarding products and or processes from SNL to private industry.

[28] Munda, G., P. Nijkamp, and P. Rietveld (1993) "Information Precision and multicriteria evaluation methods" in A. Williams and E. Giardina (eds) Efficiency in the Public Sector: The Theory and Practice of Cost-Benefit Analysis. Cambridge: University Press.

Table 1: Technology Transfer Costs and Benefits

COSTS	BENEFITS
Laboratories or Individual Firms or Industry	
1. *capital* purchase new buildings dispose obsolete buildings	1. *capital* use building more effectively/efficiently
2. *equipment* purchase new equipment/materials dispose obsolete equipment/materials/products	2. *equipment* purchase less expensive equipment/materials use equipment/materials more effectively/efficiently
3. *labor* hire/train new employees retrain/layoff current employees	3. *labor* use labor more effectively/efficiently replace labor (robotics, raise skill level required)
Society	
1. *economy* shutdown obsolete businesses decrease U.S. market share worsen balance of trade lose domestic industry increase costs product/process/service resources not applied to other options (opportunity cost) eliminate jobs	1. *economy* start-up new businesses increase U.S. market share (international transfer) improve balance of trade retain domestic industry decrease costs product/process/service resources applied to development of new or improved product/process/service create, save jobs
2. *technology/knowledge* educate experts in new technology stress to stay current in discipline	2. *technology/knowledge* increase/diffuse/spur new knowledge/technology set standards improve testing
3. *environment* clean up waste from obsolete technology clean up waste from new technology	3. *environment* prevent, reduce waste production
4. *health* increase disease/accidents/death decrease safety and decrease personal freedom	4. *health* decrease disease/accidents/death increase safety and maintain personal freedom

Public-Sector Project Cycle Phases and Program Evaluation

The intent of this discussion is to identify the context in which the evaluation of technology transfer impact is conducted. This will be accomplished in two steps: 1) briefly reviewing and comparing generic public-sector project cycle phases and generic public-sector program evaluation; and 2) contrasting the evaluation of technology transfer impact to these other types of public-sector evaluation.

Table 2: Comparison of Project Cycle Phases and Types of Program Evaluation[29]

PHASES OF PROJECT CYCLE	TYPES OF PROGRAM EVALUATION
I. The Conception Phase Supporting techniques: analysis of economic, social, political and technological trends; identification of competitive advantage; corporate strategy planning.	1. Front-end analysis preinstallation, context, feasibility analysis
II. The Validation Phase Supporting techniques: demand forecasting; risk analysis; life-cycle costing; decision analysis; *project evaluation;* net present value analysis; market research; break-even analysis; sensitivity analysis; product testing.	2. Evaluability assessment comparisons with other projects
III. The Planning Phase Supporting techniques: critical path analysis; network analysis; program evaluation and review technique (PERT); budgeting; standard costing; matrix management; contracting.	
IV. The Construction Phase Supporting techniques: cost/profit/responsibility centres; matrix management; variance analysis; bar charts/Gantt progress charts; milestone reports.	
V. The Operational Phase Supporting techniques: depreciation accounting; production and sales monitoring variance analysis; output quality testing; monitoring consumer response.	3. Formative evaluation developmental, process evaluation 4. Program monitoring
VI. The Divestment Phase Supporting techniques: identification of optimal timing of divestment; ex post investment appraisal; identification of lessons to be learned for future projects.	5. Impact evaluation summative, outcome, effectiveness
	6. Evaluation of evaluation secondary evaluation, metaevaluation, evaluation audit

The public-sector project cycle, as illustrated in Table 2, is a rational decision-making plan to follow from the inception of projects to their conclusion. Analytic techniques are used to obtain the information necessary to make the salient decision of each phase. In the project cycle, evaluation is in the validation phase, before specific planning activities begin. Evaluation is used, along with other analytic techniques, to decide between alternatives, to validate the choice of a particular project.

---

[29] This table contains information from Mayston, D. (1993) "Public and Private Sector Project Appraisal: A Comparative Evaluation" in A. Williams and E. Giardina Efficiency in the Public Sector. Cambridge, Great Britain: Edward Elgar Publishing. p. 5 and Cozzens, S., S. Popper, J. Bonomo, K. Koizumi, and A. Flanagan. "Methods for Evaluating Fundamental Science". RAND draft series: DRU-875/2-CTI. p. 16.

The phases of the project cycle correspond, in public-sector program evaluation parlance, to the following categories of program evaluation (Table 2): phase I=front-end analysis; phase II=evaluability assessment; phase V=formative, developmental, process evaluation and program monitoring; and phase VI=impact, summative, outcome, effectiveness evaluation. Generally speaking, public-sector evaluation is conducted in relation to one of three public-sector behaviors: "satisficing", "justificing", or "optimizing"[30]. The evaluation method should, therefore, be appropriate to the evaluation's objectives and available data and resources[31] (i.e. time and finances). The principle focus or objective of GPRA[32] is impact (summative, outcome or effectiveness) evaluation.

These typologies (project cycle and program evaluation) categorize public-sector evaluation according to the timing and intention of the evaluation. Since the funding for public organizations and programs is based on fairly immediate considerations (as in "What have you done for me lately?"), public-sector evaluation does not routinely entail historical, retrospective analysis as is required to ascertain the impact of transferred technology. This study does not fit neatly, therefore, into the above categories as traditionally defined.

This research can be described as impact evaluation, although its findings are not intended to facilitate the traditional use of impact evaluation, i.e., to decide whether to continue a particular program. In addition, while utilizing an optimal choice selection technique (cost-benefit analysis) of the validation phase, this research is more accurately identified as an after-the-fact investment appraisal of the so-named divestment phase, though it is not related to any divestment decision. Technology is "divested" when it becomes obsolete and/or is replaced by its sequel. The most complete and accurate investment appraisal or return on investment evaluation for a technology would be conducted at its point of obsolescence. However, in regard to sequels or the nature of technology to be in continuous development[33], one technology can be said to "breed" another, making the time boundaries for the evaluation fuzzy. The point here, again, is that the evaluation of the impact of transferred technology does not fit neatly into the standard categories of either program evaluation or public-sector project cycle evaluation.

---

[30] *Satisficing* is the term coined by Herbert Simon to distinguish actual from rational decision making whereby the actual decision making process is concluded when a sufficient, satisfactory solution is found. Theoretical, rational decision making asserts that comprehensive analysis continues until an optimal solution is found. Simon, H.(1965) Administrative Behavior New York: Free Press. ***Justificing*** refers to efforts made by public organizations to address the requirement of public accountability through providing reasons, explanations, and defenses for choices and actions. Munda, Nijkamp, and Rietveld (1993).

[31] According to Lave (1981, p. 27): "The felicitousness of the [evaluation] framework is more important that its comprehensiveness."

[32] Cozzens, S., S. Popper, J. Bonomo, K. Koizumi, A. Flanagan. (1994) "Methods for Evaluating Fundamental Science", Washington DC: RAND.

Indirect Measures of R&D Impact[34]

Indirect measures of R&D impact include: bibliometrics (citation and co-citation analysis); peer review; participation counts for training/education activities and for mechanisms designed to facilitate technology transfer; science user or customer surveys; and publication, patent, copyright, and product counts[35]. Although each of these metrics add more information, the interpretation of the meaning of the information must be made carefully due to the inherent limitations of this surrogate data[36].

For example, reviewers are subject to the bounds of human rationality, cognitive capacity, and bias. Therefore, peer review can potentially yield arbitrary, biased, or other than rational outcomes[37]. Citation analyses, whether of publications or patents, measure a representation of the output rather than the output of R&D itself. In addition, the number of citations, while communicating the existence of linkages, is not instructive concerning the importance, quality, or relative impact of the work within a field or subfield due to differences in citation patterns between disciplines[38]. Despite these and other limitations, citations and indirect measures help to paint a more detailed picture of the impact of technology transfer. Therefore, to the extent that this information is available, it will be included.

---

[33] For example, commercial impetus for the development of the transistor resulted from market pressures created by the discovery, refinement, and application of the vacuum tube. A bibliometric study might not make this connection, but a retrospective market research study would demonstrate this point.

[34] Direct refers here to measures of financial return. Indirect refers to all other measures of R&D impact.

[35] Cozzens, S., S. Popper, J. Bonomo, K. Koizumi, and A. Flanagan. "Methods for Evaluating Fundamental Science". RAND draft series: DRU-875/2-CTI. For an overview of current R&D evaluation techniques see volume 18:1 issue of *Evaluation Review*, A special issue on research impact assessment.

[36] Indirect measures (all measures other than those of financial return) yield data that is surrogate for direct measures (measures of financial return).

[37] Chubin, D. (1994) "Grants Peer Review in Theory and Practice," *Evaluation Review*. 18:1, 20-30.

Unit of Analysis

Technology transfer has been defined as "an intentional effort to transfer capability to do something from one person or organization that has the desired capability to another person or organization that wants and will use that capability"[39]. While technology transfer can occur unintentionally, only intentional efforts are studied in Phase I. The definition is stated in unitary terms but, for this research, technology transfer can include more than one recipient person or organization either from the inception of the effort or as a result of diffusion beyond the original recipient person or organization. In Phase I, technology transfer specifically refers to a transfer from Sandia National Laboratories to one or more private sector organizations.

The effort to transfer technology occurs gradually over a period of time. The approximate point in time when technology transfer can be said to be completed can only be determined retrospectively. While there is a difference between the gradual process of efforts and the approximate point of completion, this distinction is not often made in the technology transfer literature. The Stevenson-Wydler Act and subsequent legislation supported not just the effort to transfer but specific results, the successful commercialization of the technology:

> "It is the purpose of this Act to improve the economic, environmental, and social well-being of the United States by....3) stimulating improved *utilization* of federally funded technology developments including inventions, software, and training technologies, by State and local governments, and the private sector."[40] (emphasis added).

---

[38] Narin, F., D. Olivastro, and K. Stevens. (1994) "Bibliometrics/Theory, Practice, and Problems," *Evaluation Review*. 18:1. 65-76.

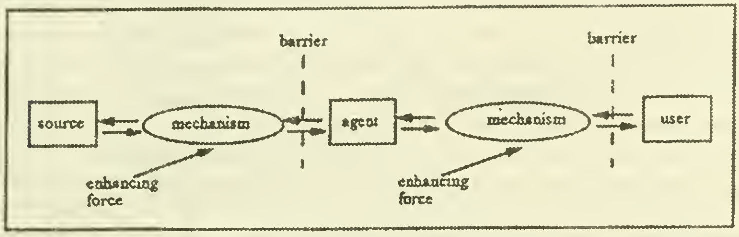
[39] DeBruin, J. and J. Corey (1988) Technology Transfer: Transferring Federal R&D results for Domestic Commercial Utilization. Sandia National Laboratories, Office of Classification and Technology Policy, Defense Programs, U.S. Department of Energy. SAND88-1716 p. 28.

[40] United States Code Title 15 Chapter 63-Technology Innovation Section 3702-Purpose (15 USC Sec. 3702).

In concert with this original intent, this research defines technology transfer as the successful commercialization of technology and therefore seeks to quantify[41] the impact of successful commercialization rather than gauge the extent of effort.

Several authors have created models to represent the technology transfer process visually. As do many, Kassicieh and Radosevich's model (Figure 1) represents technology transfer as a sequential process. The portrayal of the process of science, innovation, or technology transfer may be more accurate if depicted nonsequentially[43]. However, for this research, Kassicieh and Radosevich's model identifies the salient aspects of technology transfer.

Figure 1: Model of Technology Transfer Process[42]



While the various aspects of technology transfer are the focus of other research efforts[44], Figure 2 illustrates the components of this research. The unit of analysis for this study is neither the laboratory R&D, the technology, the transfer process (mechanisms), the parties involved in the transfer (source, agent, or user), impediments to the transfer (barriers), the program facilitating the transfer, or the institutions involved (national laboratories or Department of Energy). Instead, it is the impact of the transfer. This includes both the economic impact and the impact that is not readily quantifiable in dollar values.

---

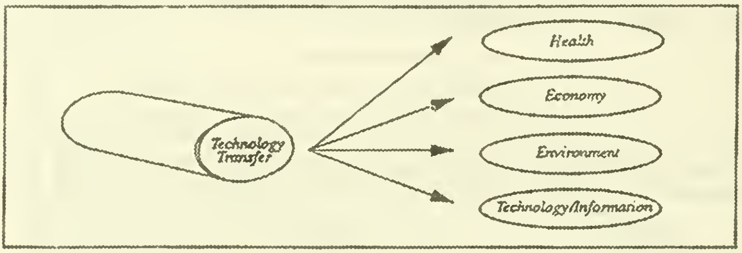
[41] Retrospective analysis is more frequently *qualitative* than quantitative.

[42] Source: Kassicieh, S. and H. Radosevich. (1993) From Lab to Market: Commercialization of Public Sector Technology. New York: Plenum Press p. 128.

[43] Papadakis, M. (1991) Bringing Science to Market: The Policy Implications of U.S. and Japanese Patterns of Science, Technology, and Competitiveness. Ann Arbor, MI: University Microfilms International Dissertation Services.

[44] Bozeman, B. and D. Roessner (1995) "R&D Value Mapping as an Approach to Assessing Technology Transfer," presentation to Oak Ridge National Laboratory, and Bozeman, B., K. Coker and M. Papadakis (1995) "Industry Perspectives on Commercial Interactions With Federal R&D Laboratories" Report to the National Science Foundation, Research on Science & Technology Program, Contract No. 9220125, January 1995.

Figure 2: Unit of Analysis: Technology Transfer Impact



Figures 3 and 4 (pages 21 and 22) identify the potential impacts of a technology transfer. Four areas of impact are considered: economy, technology/knowledge, environment, and health[45]. These impacts could be measured at eight levels:

1. individual consumer(s),
2. individual firm,
3. subset of specialized firms within an industry,
4. all firms within an industry,
5. multiple industries within an economy,
6. all industries within an economy,
7. multinational economies, and
8. worldwide.

For each transfer, data will be included for each level appropriate to the transfer and industries involved. Impact can range from worldwide to exclusively local. As more profiles are completed, the likelihood of obtaining data on transfers with impact at similar levels will be increased. For now, this research is focused on identifying, quantifying, and classifying the impacts to achieve the most quantitative assessment possible for each transfer. In Figures

---

[45] These four areas represent a classification of the indicators commonly reported in articles and reports on R&D and technology transfer evaluation to which were added indicators of environmental and health or quality of life impact.

3 and 4, a possible scale for each of the metrics is indicated. As more profiles are completed, it is anticipated that the appropriate scales to use to enable comparison will be apparent. The differences in technologies transferred and constraints on resources and data availability preclude obtaining data for each metric for every technology transfer. However, the intent of the study is to obtain data for as many indicators as availability and appropriateness permit.

In the area of economy, the impact of technology transfer is measured using job counts, industry dispersal, business counts, and cost-benefit ratios. In regard to job counts, to present an accurate accounting of economic impact, it may seem reasonable to reduce the credit for the prosperity engendered by the successful commercialization of a new technology by an accounting of the loss of sales and workers displaced by the replacement of the existing technology. However, technology is necessarily destructive and creative simultaneously. As the old technology is made obsolete, the new technology increases the efficiency of resource usage. The resources that are unused by the more efficient new technology and would have been expended using the old, are now free to be applied to a more efficient use. In a moderately competitive economy, the displaced workers are only temporarily, not permanently, unemployed. Society experiences a net gain not loss from new technology. Therefore, since it would misrepresent the true impact to reduce benefits by the effects of the replacement of the old technology, that reduction is not commonly included in assessments of the impact of new technology and will not be included here. Job counts will be gross not net new jobs.

Industry dispersal refers to the number of companies (reported as a percentage) within an industry receiving the technology that, as a result of the transfer, have implemented the technology. The number of successful new business startups resulting from the transfer and of types of business users of the products of the technology transfer are both also counted.

Two approaches to measuring costs are used in calculating the cost-benefit ratio. The first includes both the cost of producing knowledge and the cost of the transfer. The second includes only the cost of the transfer. The national laboratories are multiprogram laboratories, with R&D programs in national security, energy resources, environmental quality, and industrial competitiveness. For some technology transfers, the cost of producing knowledge should all be allocated to the transfer. For those transfers of technology developed for a specific purpose such as national security, counting only the cost of the transfer may be a more realistic cost figure because the laboratory cost to produce the knowledge is often a sunk cost, unrelated to the actual transfer. It would have been incurred regardless of whether or not the transfer occurred, since the laboratory needed and used the knowledge for other purposes[46]. The benefit of national security and a viable defense were the intended and realized return on the investment made to produce the knowledge. Since there is not a valid basis to apportion a part of these sunk costs to the transfer, two ratios are calculated, one with these sunk costs included and the other with sunk costs excluded.

The cost to produce the knowledge refers here to the investment made by SNL to create or obtain expertise in a technology. The cost of producing knowledge is measured by including the cost of capital, equipment, and labor. The fully burdened historical annual cost of the average scientific technical person at the laboratory includes operational R&D costs such as the cost of overhead for buildings, their maintenance, equipment under $10,000 and purchases of incidental materials. This average annual cost is multiplied by the total number of scientific and technical persons involved in obtaining the targeted technology each year. The SNL managers in each transfer were consulted to determine if facilities were constructed or equipment costing more than $10,000 was purchased for SNL to obtain the technologies involved. The value in 1987 dollars of these capital, equipment, and labor costs for each year is calculated using the GDP deflator series[47]. The sum of these yearly costs is presented as the total cost of producing the knowledge for SNL in this study. The cost of the transfer is measured by the amount of government and private sector investment allocated to the transfer. This can include grants, salaries, lodging, training, travel, equipment, facilities, and related costs.

Benefits are measured with estimates of cost savings, government multipliers for economic impact, and sales estimates. Appropriate published data and industry experts were consulted to estimate cost savings and sales. The U.S. Department of Commerce's Bureau of

---

[46] It is difficult and expensive to assess all of the sunk costs in defense research. In addition, all of the benefits derived from the investment in defense research are also difficult to trace since results are often published and dispersed widely, contributing to many different fields. If it were possible to trace the benefits of all research to all industries, the truest measure of impact could be derived. However, when data is publicly released and can be used without citation, it is impractical to produce a truly all-inclusive assessment of impact.

[47] This deflator series is widely available. There is nothing obscure about how it works, and most federal salaries are tied to it. See Shires, M. (1993) "Estimating a Research and Development Price Index". Santa Monica, CA: RAND. and Bureau of Economic Analysis, Department of Commerce "Implicit Price Deflators for Gross Domestic Product" (1995) Economic Indicators. Washington D.C.: Government Printing Office. March p. 2.

Economic Analysis (BEA) has provided published multipliers[48] by state available at no cost and will calculate multipliers for specific industries in specific counties or regions on a fee basis. Due to budgetary and time restrictions, the published Regional Input-Output Modeling System (RIMS II) input-output multipliers are used in this report. Although the published multipliers are not as current as those obtainable for a fee, the multipliers used in this report, ranging from 1.6 to 2.0, are reasonable and conservative for the estimation of the regional economic impacts of the introduction of a new technology[49]. In addition, nonmonetary indicators of benefit such as jobs created, the use of transferred technology within an industry, and counts of new business startups related to the transfer, as mentioned earlier, were also sought.

In the area of technology/knowledge, the impact of technology transfer is measured by counts of tangible outputs of the transfer (products, devices, incremental improvements, successful problem solving, and algorithms/software) and surrogate measures of these outputs (patents, publications/presentations, postdoctoral research, and industry training). These measures are all enumerations[50]. Successful problem solving refers to the number of problems solved to facilitate production, commercialization, or marketability of the technology.

The impact in the area of environment is measured by estimates of known increments or decrements to the number of pollutants in the air, water, or waste related to the technology transferred. The pollutants are qualitatively graded to indicate the severity of the risk they pose and reported according to the number of pollutants within each grade[51].

In regard to health, data on changes in accident or death rates related to the

---

[48] Regional Economic Analysis Division, Bureau of Economic Analysis, Department of Commerce. (1992) Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System (RIMS II). Washington DC: Government Printing Office. May.

[49] The Director of the Bureau of Business and Economic Research at the University of New Mexico, an expert in economic impact studies, assessed the use of the RIMS II multipliers in this report and found that their use was both appropriate and conservative.

[50] It is important to note that while the aggregate of the enumerations for the four areas of impact will create an overall profile of impact, the assertion is NOT being made here that the individual enumerations (for example the number of patents) equate to impact because the enumerations alone may only represent potential rather than actual impact.

[51] The grading and evaluation will be done in accordance with federal legislative and regulatory classification of pollutants (see National Environmental Protection Act (NEPA) 1970, Toxic Substances Control Act 1970, and National Clean Water Act (1977,1981,1987), National Clean Air Act, etc.)

Figure 3. Impact Profile

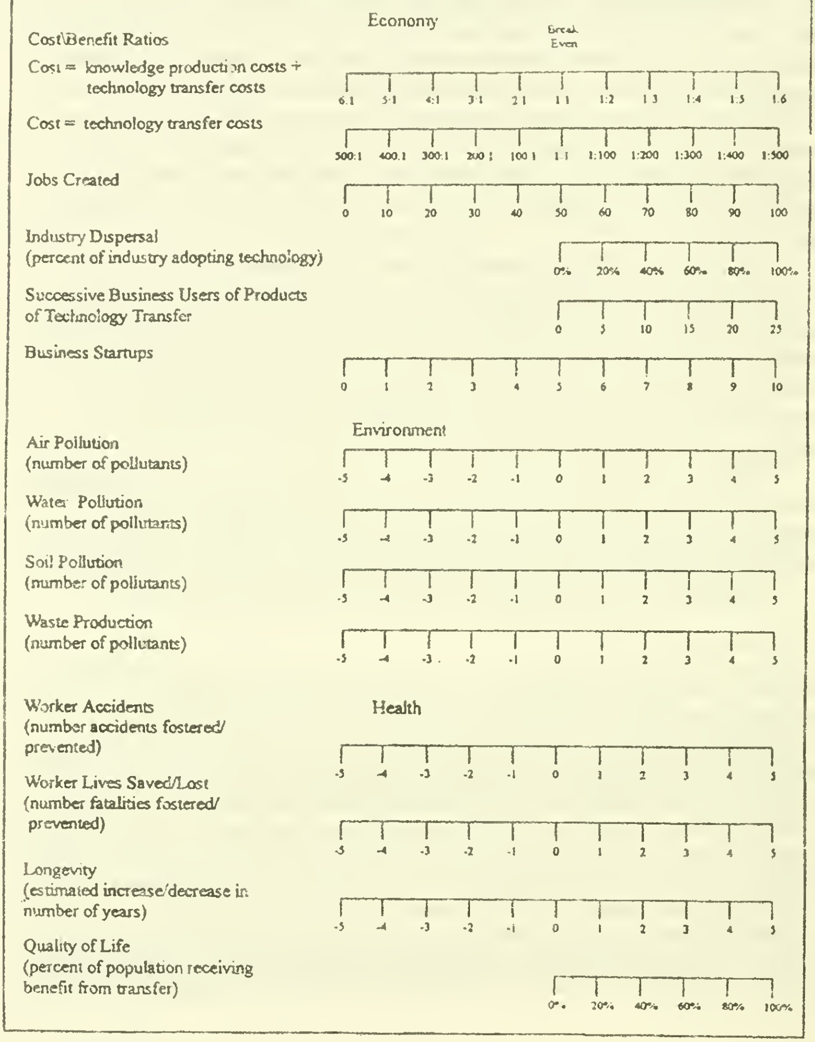
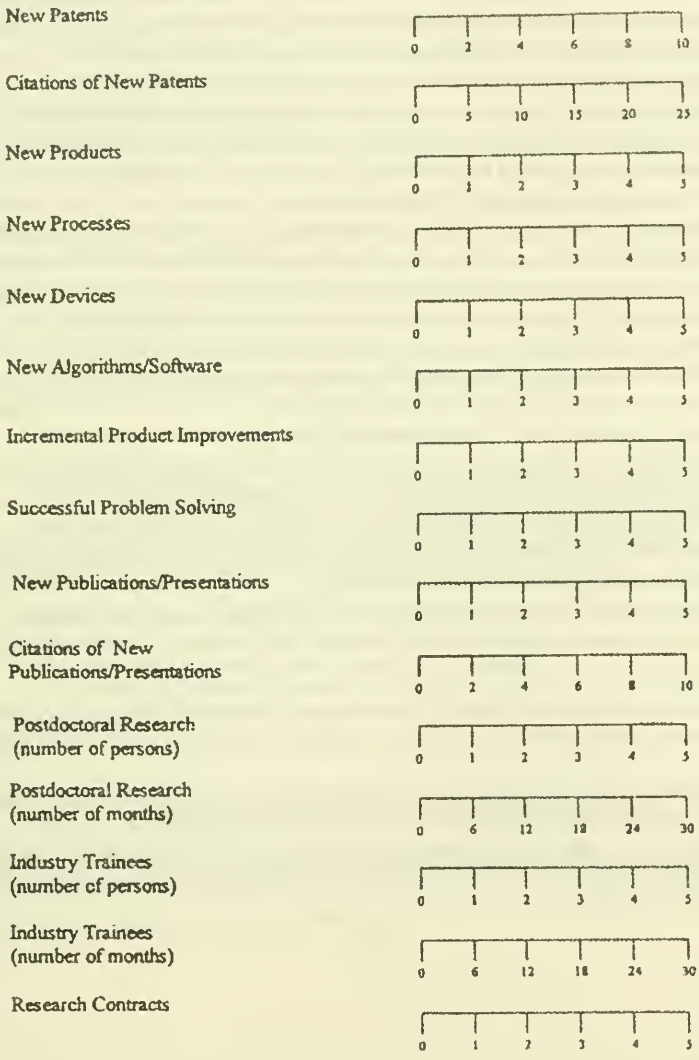

Economy
Cost\Benefit Ratios
Break Even
Cost = knowledge production costs + technology transfer costs
6:1 5:1 4:1 3:1 2:1 1:1 1:2 1:3 1:4 1:5 1:6
Cost = technology transfer costs
500:1 400:1 300:1 200:1 100:1 1:1 1:100 1:200 1:300 1:400 1:500
Jobs Created
0 10 20 30 40 50 60 70 80 90 100
Industry Dispersal (percent of industry adopting technology)
0% 20% 40% 60% 80% 100%
Successive Business Users of Products of Technology Transfer
0 5 10 15 20 25
Business Startups
0 1 2 3 4 5 6 7 8 9 10
Environment
Air Pollution (number of pollutants)
-5 -4 -3 -2 -1 0 1 2 3 4 5
Water Pollution (number of pollutants)
-5 -4 -3 -2 -1 0 1 2 3 4 5
Soil Pollution (number of pollutants)
-5 -4 -3 -2 -1 0 1 2 3 4 5
Waste Production (number of pollutants)
-5 -4 -3 -2 -1 0 1 2 3 4 5
Health
Worker Accidents (number accidents fostered/ prevented)
-5 -4 -3 -2 -1 0 1 2 3 4 5
Worker Lives Saved/Lost (number fatalities fostered/ prevented)
-5 -4 -3 -2 -1 0 1 2 3 4 5
Longevity (estimated increase/decrease in number of years)
-5 -4 -3 -2 -1 0 1 2 3 4 5
Quality of Life (percent of population receiving benefit from transfer)
0% 20% 40% 60% 80% 100%

Figure 4: Impact Profile

Technology/Information



technology transferred is reported for the employees within industries and for the public, if applicable and significant. Estimates of verified influence on changes in longevity or quality of life for employees and for the public, if applicable and significant, will also be sought.

Selection of the Technology Transfers

A time lag exists between the transfer of technology and evidence of its impact. To allow enough time for the impact of the transferred technology to be measurable, technologies were selected that had been transferred at least three years prior to the beginning of this study[52]. Two technology transfers were selected for this preliminary research: plasma spray technology transferred to Fisher-Barton, Inc. and polycrystalline diamond drill bits transferred to the rock drill bit industry. These two technologies were selected as dissimilar examples of SNL technology transfer.

The plasma spray transfer involves a small business, an industry less than 100 years old and the startup of a new small business. The polycrystalline diamond drill bit transfer involves small, medium, and very large businesses, an industry more than 100 years old, and robust competition. The disparity between the two transfers provides a test of the comprehensiveness of the research method. The results of this research show whether it can accommodate two extremes on the continuum of technology transfers from SNL.

The total population of documented technology transfers to date from Sandia National Laboratories is well over 1000[53]. For the most part, the transfers are technologies from within the Laboratories' technical core competencies. The core competencies consist of four scientific research foundations (engineered materials and processes, microelectronics and photonics, computational and information sciences, and engineering sciences) and four integrated capabilities (advanced manufacturing technology, electronics technology, advanced information technology, and pulsed power technology)[54]. Another classification for SNL is in regard to the mode by which the transfers occur. For example, transfers occur through cooperative agreements, technical assistance programs, and publication of research findings.

---

[52] The transfers selected occurred prior to the increased emphasis on technology transfer. With the increased funding, planning, and support, subsequent transfers may achieve much greater impact.

[53] If literature citations and more casual exchanges of data were included, the transfers would number in the many thousands. Source. SNL technology transfer official.

[54] SEAB (1994) "Visit of the Secretary of Energy Advisory Board (SEAB) Task Force on Alternative Futures for the DOE National Laboratories August 16, 1994", Sandia National Laboratories' Itinerary.

For the results of this research to be generalizable to the Laboratories' technology transfer activity, stratified sampling of the transfers by the core competencies with consideration of the modes of transfer would need to be used. This would offer a sample size sufficient for separate subgroup analysis, an increase in the sample efficiency, and an adequate population frame (to cover the population of transfers uniformly)[55]. The cost of obtaining data for a sample of this size would, however, be prohibitive. A more limited study may be sufficient to demonstrate the impact of the specific technologies transferred and will provide an experiential basis for estimating the value of a broader array of transfers.

Phase I is a step toward that goal. Thermal spray is within the engineered materials and processes core competency and the transfer occurred through a DOE technical assistance program for small businesses. Polycrystalline diamond drill bit technology is within the engineered materials and processes core competency but is also very interdisciplinary including technologies from the computational and information sciences and engineering sciences (mechanical design and fluid mechanics) core competencies. This transfer occurred through Industry Advisory Committees and industry and university research funded by SNL. The technologies studied do not represent the breadth of science-based engineering of the core competencies. There is no intention, therefore, to generalize the findings of this initial study, but there is intent to do so when further study has been completed.

Data Collection

The transfer of technology is the transfer of knowledge. Knowledge, like wind, is more apparent in its effect than its essence. This intangible aspect, coupled with the myriad types of knowledge and transfer mechanisms, make standardization of the evaluation of its transfer a challenge. Prospective technology transfer evaluators are cautioned:

> "...there is no right method for impact assessment[56]"

> "...the conditions under which these methods can be applied
> are context-dependent...the task is to chose the right
> method for the particular problem[57]"

---

[55] Rossi, P., J. Wright, and A. Anderson (eds) (1983) Handbook of Survey Research. Orlando, FL: Academic Press.

[56] Ormala, E. (1994) "Impact Assessment: European Experience of Qualitative Methods and Practices" *Evaluation Review* 41-51 p. 49.

[57] Ibid. Munda, Nijkamp and Rietveld (1993) p. 61.

Yet technology transfer evaluators are also instructed that: "The current technology transfer M&E[58] effort is ad hoc and uneven. An improved system of measurement and evaluation is necessary and feasible and should be developed.[59]" This study experimented with the extent of standardization possible in applying a method to evaluate the impact of technology transfer within the context of the breadth of science-based engineering at the Laboratories. The following narrative documents the procedures followed to obtain the information used to prepare the impact profiles.

As noted earlier, to make this study as generally applicable as possible, the technology transfers to be studied were selected by SNL from the opposite ends of the broad spectrum of transfers[60]. Focus-group and individual interviews were conducted with the scientists and engineers at SNL associated with the two technologies. Recipients of the technology transferred and their customers were interviewed either in focus groups or by telephone. Focus-group interviews were recorded and transcribed. Logs of phone interviews were prepared. Interviewees were assured of personal anonymity and, when requested, the identity of their companies was protected.

The data from these interviews present experts' best estimates. No matter how exact and "science-like" estimates may appear, the fact that they deal with predicted events means that they are inherently imprecise[61]. However, to the greatest extent possible, independent reports of the data were obtained. The internal consistency of the information was supported by careful review of the material obtained in each interview. External consistency of the information was supported by verifying that the independent reports were in agreement[62]. The information was reviewed by all sources of information for accuracy and to ensure proprietary concerns were protected.

---

[58] measurement and evaluation system

[59] Carr, R. (1994) "A Proposal for a framework for measuring and evaluating technology transfer from the federal laboratories to industry" in Kassicieh, S. and H. Radosevich (1994) From Lab to Market: Commercialization of Public Sector Technology. New York: Plenum Press p. 303.

[60] A former manager of SNL technology transfer reviewed SNL technology transfers, choosing two transfers that met the following criteria: 1) successful transfers; 2) different from each other (in technology, transfer mechanism, type industry, time since transfer, etc.); 3) SNL maintained contact with the industries involved in the transfers; and 4) the industries would probably be receptive to participating in the study.

[61] For a general discussion of the scientific status of future-oriented evaluations see Rescher, N. (1959) "On the Epistemology of the Inexact Sciences" *Management Science* 6:1 25-52. For a targeted discussion of the problems in future-oriented evaluation of R&D impacts see McCullough, J. (1989) "First Comprehensive Survey of NSF Applicants Focuses on their Concerns about Proposal Review" *Science, Technology, and Human Values* 14:1 78-88.

Documents published by SNL, trade publications, and scholarly journal and proceedings articles were also used as source material. Citation and patent searches were done using the SCI and CASSIS databases. In addition, records, when available, were obtained from companies and industry associations for each of the four areas (economy, technology/knowledge, environment, and health). These procedures enable future replication by following recommendations to facilitate replication[63] (standardization and thorough documentation of evaluation procedures and maintenance of records of the technology transfer recipients).

---

[62] Lofland, J. and L. Lofland. (1984)Analyzing Social Settings. Belmont, CA: Wadsworth Publishing Company.

[63] Ibid. Lofland and Lofland (1984).

Overview of Thermal Spray Technology and Industry

Thermal spray is a generic term for an aerosol spray of molten material. The spray can be used to coat components or objects, form a component or object, or process a material. In thermal spray, a material (in powder, wire, or rod form) is heated to a molten or semi-molten state, accelerated, and propelled toward a prepared surface. As a coating, the initial particles bond with the surface and subsequent particles then cause thickness buildup. In spray forming, the particles build up a thick deposit which is removed from the substrate (often referred to as a mandril) to create a free-standing shape. In material processing, unusual materials (e.g., nickel graphite and aluminum polyester composites for abradable seals and cemented carbides for wear applications) that cannot be made any other way are formed during the process. Originally (from 1909 to circa 1950), the materials sprayed were molten metals. More recently, nonmetallic and mixtures of nonmetallic and metallic materials are sprayed. Thermal spray can be classified by process into three general categories[64]: plasma, combustion, and electric/wire-arc spray. Table 3 highlights the differences between these processes.

Thermal spray was first used by M. U. Schoop in Zurich, Switzerland in 1909 to make metal powder. The thermal spray industry began in the 1920s with the subsequent introduction of metal spraying to the marketplace in Germany, France, and the United States. The industry experienced slow, steady growth in the United States with annual sales reaching approximately ten million dollars in the 1950s. The advent of technological innovation (plasma spray torch) and the expansion of markets (thermal and wear resistant coatings for aircraft engines) boosted annual sales to approximately $50 million by the early 1970s. Industry restructuring (through acquisitions and startups), fast-paced technological innovation (high velocity oxyfuel [HVOF], computer based controls, high-energy plasma spraying, water-jet stripping of thermal spray coatings, laser melting, and robotics) and new markets (automotive applications and relatively small niche users) brought annual sales to $630 million in the United States and $1.2 billion worldwide by the early 1990s[65].

---

[64] Many subdivisions exist within the three general categories. There is not one best process, each application must be carefully studied to achieve the desired coating characteristics using the most appropriate process.

[65] Thorpe, M. (1993) "Thermal Spray," *Advanced Materials and Processes* 5:143 50-61. Annual sales refer to sales of thermal spray services.

Table 3: Thermal Spray Coating Processes[66]

Type of Process	Mechanisms	Variations of Each Type	Cost/Availability	Deposit Characteristics
Combustion	based on chemical heating from oxygen fuel combustion	flame spray	least expensive	more porous, higher oxide content
		detonation gun	patent available from one vendor only	high quality coating, not suited for coating large surface areas
		HVOF[67]	more expensive	very thick, low porosity coating, with low residual stress
Plasma	based on heating by a direct current arc-driven plasma jet	atmospheric spraying	least expensive	very versatile, some porosity/oxide (spraying in open air)
		vacuum/low pressure	high cost	greatly superior coatings for some applications (extensive use in aerospace applications)
		inert chamber	intermediate in cost	reduced oxides/porosity, not widely used in industry
		underwater	no commercial application	
Electric/Wire Arc	based on heating by an electric arc struck between two consumable wires	atmospheric spraying	relatively inexpensive	high deposition rates, somewhat porous, minimal heat input to workpiece, limit to metal coatings with comparatively rough as-deposited surface
		vacuum	research only	limited use in Europe at present
		inert	research only	limited use in Europe at present

The major players in the industry are job shops, original-equipment manufacturers (OEMs), the military, and suppliers of equipment, systems, and materials. The number of users of this technology continues to increase through such recent applications as coatings for medical implants[68], spray forming[69], and removal of lead-based paints[70] from steel structures. Industry restructuring is also continuing in the 1990s with consolidations, buyouts, and reassessment of thermal spray as a "factory-floor" process by OEMs. Since it constitutes fifty percent of annual sales, slowdowns in the aircraft engine repair business have had marked impact on the thermal spray industry in the United States in the 1990s[71]. In addition, the 1994-1995 acquisition (and in some cases, taking off-shore) of 80% of the U.S. companies that supply thermal spray equipment, systems, and materials by foreign interests is anticipated to have a major impact on the industry in the United States since technological innovation has been fostered primarily through these suppliers[72].

---

[66] Source: Manager SNL Thermal Spray Research Laboratory and Smith, R. and R. Novak. (1991) "Advances and Applications in U.S. Thermal Spray Technology I. Technology and Materials," *Powder Metallurgy International*. 23:3.

[67] high velocity oxy-fuel

[68] Herman, H. and S. Sampath. (1995) "Thermal Spray Coatings". posted on internet: Department of Materials Science and Engineering, State University of New York at Stony Brook. June 1995. contact cberndt@ccmail.sunysb.edu, 15 pages.

[69] Smith, R. and R. Novak. (1991) "Advances and Applications in U.S. Thermal Spray Technology I. Technology and Materials," *Powder Metallurgy International*. 23:3.

[70] Berndt, C. (1995) "Removal of lead-based paints from steel structures". posted on internet: Department of Materials Science and Engineering at State University of New York at Stony Brook. contact cberndt@ccmail.sunysb.edu June 1995. 1 page

Thermal Spray Technology Transfer

Sandia National Laboratories began its research in thermal spray technology to support the defense effort in 1967. The Laboratories developed thermal spray expertise and capacity in virtually all thermal spray technologies including: combustion flame spray (two or three types), twin wire arc, conventional atmospheric plasma, single wire plasma, vacuum spray, and HVOF. Applications of the technology at the Laboratories include defense, solar energy, and the magnetic confinement fusion energy project, along with numerous projects with industry. The thermal spray process called plasma spray is the technology transferred from Sandia National Laboratories to Fisher-Barton Inc. on which this study focused.

Plasma Spray

The following is a layman's description of the plasma spray process. A mixture of gases, usually argon with either helium or hydrogen, is fed into a gunlike apparatus. Within the gun, the mixed gas passes between an anode and a cathode. The electrical energy that is imparted by the flow of electrical current through the gas, ionizes the gas (strips its electrons). Ionized gas is also called plasma or gas in an excited state. The ionization of the gas creates heat in the form of a high velocity plasma jet. This plasma jet will both melt material and propel the particles of melted material out of the gun. Material (powder, wire, or rod) is fed into the core of the plasma within the gun. The plasma melts the material and propels it out of the gun in molten aerosol droplets (Figure 5).

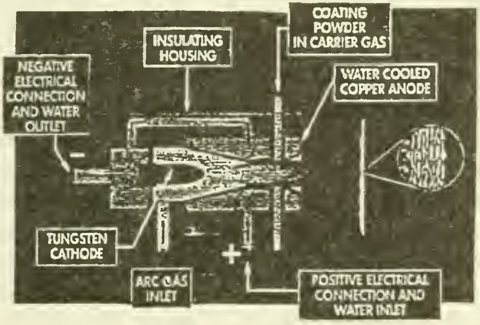
Plasma generated by the flow of electric current can create very high temperatures, higher than can be obtained with combustion processes. This high temperature makes the plasma a superior process for spraying materials with very high melting points, such as ceramics. The melting point of a typical sprayed ceramic is 4,000°F. The surface temperature of the component to be coated may have a melting point of only 1,000°F. The component is therefore kept below 250°F to prevent the heat of the molten ceramic from distorting its shape.

---

[71] Personal interview, thermal spray consultant, June 1995. and Thorpe, M. (1993) "Thermal Spray," *Advanced Materials and Processes*. 5:143. 50-61.

[72] Personal interview, thermal spray industry official. June 1995.

Figure 5: Plasma Spray Diagram


COATING POWDER IN CARRIER GAS
INSULATING HOUSING
NEGATIVE ELECTRICAL CONNECTION AND WATER OUTLET
WATER COOLED COPPER ANODE
TUNGSTEN CATHODE
ARC GAS INLET
POSITIVE ELECTRICAL CONNECTION AND WATER INLET

Fisher-Barton Inc.[73]

Fisher-Barton Inc. manufactures gear blanks and original and replacement metal blades for several applications including: lawn mowers, wood chippers, and agricultural machinery. The company employs 270 workers and transacts business in four locations: Watertown (corporate headquarters), Pewaukee, and Milwaukee, Wisconsin and Greenville, South Carolina. Founded in 1973, it is currently the largest manufacturer of lawn mower blades in the world (fifty percent share of the available world market)[74]. To expand its research and development capacity, Fisher-Barton maintains an ongoing professional relationship with the University of Wisconsin (UW-Madison)[75].

The company's goal is to make the best lawn mower blade in the world. Lawn mowers operate like a vacuum cleaner in a brutal environment. The rotating blade (3,000-3,500 rpm, or ≈200 mph) not only raises grass for cutting, but also picks up rocks and, in some parts of the United States, sand. The sand is devastating to the blade, eroding it in as little as ten hours. In 1980, Fisher-Barton wanted to measure the durability of its blades. The UW-Madison's College of Engineering helped Fisher-Barton to scientifically verify that the heat treatment or austempering Fisher-Barton uses on its blades did, in fact, increase their wear resistance and decrease their likelihood of failure[76].

---

[73] The information in this section was primarily obtained during interviews at Sandia National Laboratories in New Mexico, and at Fisher-Barton and Thermal Spray Technologies in Wisconsin.

[74] Some captive lawn and garden product companies manufacture their own blades.

[75] Home of the University of Wisconsin Badgers, 1994 Rose Bowl Champions.

A professor in the Materials Science and Engineering Department of the UW-Madison College of Engineering further directed Fisher-Barton toward thermal spray as a possible technology to increase the durability of its blades and to overcome the limitations of metal working processes. In 1986, a graduate engineering student began to study the technology at UW-Madison through available literature and samples of plasma-sprayed items. While the University faculty did not have plasma spray equipment or the applied expertise to experimentally test the lawn mower blade application, the study indicated that plasma spray coatings would be too brittle to use in the field.

Technology Transfer Grant

During a serendipitous visit to Sandia National Laboratories, the owner of Fisher-Barton realized that the Laboratories had the capacity to fully transfer plasma spray technology to the company. Fisher-Barton, Inc. then applied for and received a technology transfer grant from a Department of Energy program to aid technology transfer to small businesses. This program, available to all small businesses at that time, enabled Fisher-Barton to send its fulltime employee (formerly the graduate engineering student) to Sandia National Laboratories to work directly with Sandia experts in plasma spray technology. According to the terms of the grant, Fisher-Barton paid the employee's salary and the grant paid for laboratory supplies and the employee's living expenses.

Since plasma spray coatings for lawn mower blades were not a viable application, the Fisher-Barton research (from June 1988 - September 1989) at Sandia explored possible coatings to use on chipper blades, a product market that Fisher-Barton was considering entering. Chipper blades are used by the wood industry in the process of making pressed wood boards. They are also used in the mulching industry, an attractive growth application for Fisher-Barton. It was hypothesized that if a very hard, wear-resistant material was plasma-sprayed onto one side of the chipper blade and the other side remained conventional steel, then, as the blades chipped at the wood, the softer un-coated steel side of the blade would wear, leaving a sharp edge at all times. This idea was drawn from an example in nature. As a beaver gnaws, the softer inside covering of its incisors wears more quickly than the very hard outer covering, causing these front four teeth to be continually sharpened. This investigation found that the environment for chipper blades (like lawn mower blades) is too severe for a plasma spray coating to be effective.

---

[76] Walljasper, A. (1992) "The College of Engineering's plasma spray technology spurs a new company" in At Work for Wisconsin, publication of University of Wisconsin-Madison College of Engineering.

In addition to this project, the Fisher-Barton employee worked on other projects of specific interest to either Fisher-Barton or Sandia during the 15 month period. Although Fisher-Barton sent several projects with the employee to the Laboratories for study, the employee's primary task was to learn how to use and modify plasma spray technology for a desired outcome in a more general sense. This required developing expertise in the diagnostic techniques and computer models used to understand the materials (i.e., scientifically design and analyze the coatings) and the process (i.e., particle velocity, temperature, injection diameter, etc.). The transfer was preceded by gaining familiarity with the technology at the University but actually occurred when the hands-on knowledge about the technology was transmitted to the employee at the Laboratories[77]. The employee cited two reasons why this exchange occurred at the Laboratories: 1) the depth and breadth of expertise available at the Laboratories -

> "There was an expert there at Sandia or there was at least somebody that knew an expert that you could call up and the resources and the networking there are just so quick and fast for you to be able to get technology...".[78]

and 2) the physical resources "I got used to using great equipment."[79] According to the owner of Fisher-Barton, the greatest value of the Sandia experience was the acquisition of knowledge on how to scientifically analyze various coatings and how to select the optimal coating solution for each application. From the Laboratories' viewpoint, the transfer was a successful experience for both the Laboratories and Fisher-Barton because of the Fisher-Barton employee:

---

[77] There is a vast literature confirming that technologies are most effectively transferred from federal laboratories through person-to-person contacts.

[78] Personal Interviews conducted at Thermal Spray Technologies, Inc. October 1, 1994.

[79] TST, 1994.

> "..it's something worth observing that [when] projects of this sort come to pass, fortunately or unfortunately, success really does depend on individuals and we were very fortunate to have an outstanding individual *(referring to the Fisher-Barton employee)* in this case."[80]

After returning to Watertown, the Fisher-Barton employee assumed a management role in the purchase of plasma spray equipment and the startup of a plasma spray division within Fisher-Barton. Applications for Fisher-Barton products and additional applications for other companies provided the division with a diverse client base. In 1993, the plasma spray division was formed into a new company, Thermal Spray Technologies (TST). In 1994, Thermal Spray Technologies opened the doors of its new facility in Sun Prairie, Wisconsin, with 10 employees.

Impact of Plasma Spray Technology Transfer

The data from four applications, representing more than 50% of the annual sales of TST, were used to develop the impact profile for this technology transfer. The applications are the following:

1. automotive integrated circuit brackets,
2. road and mountain bicycle rims,
3. paper processing coater blades, and
4. food processing pump components.

Figure 6 (page 45) represents the impact of the plasma spray technology transfer from Sandia National Laboratories to Fisher-Barton, Inc. in regard to health, economy, and technology/information.

Health

Plasma spray is produced within a robotic, gunlike apparatus which propels the spray onto a prepared surface within a noise control booth. The unused plume of spray is drawn into an air filtration system using an exhaust fan. The spray is filtered and the coating material is collected in barrels from which it can be recycled and used for future applications. All of the materials used have tested as nonhazardous but, to ensure safety, workers wear protective respirators when working inside the booths Workers monitor the spraying process through the booths' glass windows, which are covered by shaded curtains. They wear standard safety glasses for monitoring outside and either dark glasses or a welder's mask for work inside the booths, as the high velocity flame is bright (5,000-30,000°K). They also wear noise protection, as the gun and exhaust system is loud (120 decibels).

---

[80] (SNL) Personal Interviews conducted at Sandia National Laboratories, (September 9, 1994). Parenthetical information added.

TST does not replace an existing manufacturing process, so worker accidents at TST do not represent an increase or decrease in accidents related to an existing technology. The annual number of accidents for the plasma spray division at Fisher-Barton and TST for the years 1989-1994 was one to two per year. The fluctuation in the number of accidents was related to influences (carelessness, new employee learning curve, etc.) other than the introduction of a new technology, per se, so this indicator is not relevant to this technology transfer. This is also true of worker lives saved/lost, i.e. it is not an indicator relevant to this technology transfer.

The increase/decrease in longevity related to this technology transfer, although potentially existent, would be fairly small and highly speculative. For example, the bicycle rim application will increase the braking capacity of road and mountain bikes on which the rims are installed when used on wet surfaces. It is conceivable that this increased braking capacity could reduce the risk of accident or save a bicyclist's life that would otherwise have been lost. Approximately 2.2% of the population participates in road biking and 2.7% participates in mountain biking[81]. The subset of the 4.9% that would be affected is fairly small (industry experts estimate 1%) because the ceramic rims are very expensive, catering to a very small elite group of bicycle racers and enthusiasts.

In addition, it is possible that the reduced failure rate for the integrated circuit bracket may prevent auto accidents and or deaths due to mechanical failure that would otherwise have occurred. The avoidance of risk associated with these technological improvements is not readily quantifiable because the extent of risk to the general population is very small. This indicator is intended, however, to capture reduction or increases in quantifiable, known risks to the general population rather than unknown or remote risks. Therefore this indicator is not applicable at this time to this technology transfer.

The quality of life indicator, however, is applicable to this technology transfer in three applications. Fifteen thousand estimated automotive circuit bracket failures would be avoided. Assuming one car per owner, .006% of the population of the United States (262M (rounded)[82] would be affected. Approximately .05% of the population enjoy increased quality in biking. Finally, food data is classified by the type of process it undergoes (ie., freezing, canning, etc.). The classification of "processed" is both broad and vague. Due to confidentiality concerns, more precise data was unavailable. However, industry experts estimate that at least fifty percent of food that is processed using food pumps is affected. Since at least 99% of Americans consume food that has been processed using food pumps, the estimate that 50% of the population in the U.S. is affected (by avoidance of increased food costs due to pump failure) was viewed as conservative. The three applications affect at least 50.056% or 50% of the public.

---

[81] Media Mark Research Sports and Recreation Report (1994). Volume 13. New York: Media Mark Research, Inc. p. 1.

Environment

In regard to coating, components and objects are coated with a variety of materials to obtain specific surface characteristics and for protection, preservation, and appearance. Four types of coatings are: physical vapor deposition (PVD), chemical vapor deposition (CVD), electroplating and thermal spray. While no coating process is ideal for all applications, the advantages to thermal spray coating are the following:

1. High deposition rates (can create very thick coatings);
2. chemical reactions are not a concern as in CVD;
3. vapor pressure is not a concern as in CVD or PVD; and
4. environmental hazard is not as much a concern as in electroplating.

As previously mentioned, in plasma spray, the unused coating spray is contained within the enclosed area and filtered through an exhaust system. The particulate material is deposited into a barrel and the unused, nontoxic gases are vented into the air. Since the particulate material can be recycled, this technology transfer results in neither increasing nor decreasing the number of water, air, or soil pollutants or waste products. Thermal spray can replace some electroplating processes. For example, applications requiring 100 to 200 different chemical products can be replaced by processes requiring one or two chemicals. Thermal spray can also replace painting and coating processes that use materials containing solvents that are more toxic and harder to remove from the atmosphere than the particulate of the thermal spray process. If TST is ever engaged in either of these types of applications, it would enhance the contribution of this technology transfer to the environment.

---

[82] Estimates of the Population of the United States to December 1, 1994. Bureau of the Census Current Population Report Series P-25. Government Printing Office February 1995.

Technology/Information

The research conducted at Sandia by the Fisher-Barton employee (i.e., technology transfer) increased information[83] through four presentations and four published articles. Four presentations were made at national conferences; three of these received best paper awards. Four technical articles coauthored with a Sandia scientist were published in technical journals. Citation analysis yielded five citations of these published articles. Technology[84] increased, as one patent was issued in 1994. Patent citation analysis did not yield any citations, perhaps due to the very recent issue date.

In 1988, the Fisher-Barton employee was approached by the Institute of Paper Science to explore the potential of a paper-making application (impulse drying). The hypothesis was that plasma spray might be useful in the drying sequence of the paper-making process, an extremely energy-intensive operation. In conventional paper production, wet paper fiber is approximately 98% water and 2% pulp, prior to the drying sequence. The water is removed by suction and then pressed, heated, and evaporated out of the fiber as it is carried on felt sheets through steel rolls. Since water has a high heat capacity and a high heat of vaporization, this process is very energy-intensive. In impulse drying, as the paper feed stock is passed through rolls heated to high temperature, the water is flashed to steam, creating a steam wave that pushes the water out. In experiments, the transfer of heat to the paper feedstock was uncontrolled using conventional steel rolls and controlled when using ceramic-coated rolls. In the uncontrolled heat transfer, when the superheated water flashed to steam at the pinch point between the conventional rolls, the paper blew apart. The controlled transfer, made possible by the ceramic-coated rolls, produced paper of higher quality and greater strength, using lower-grade pulp (with higher percentage of recycled paper) than paper made using conventional steel rolls.

TST began a joint research project with Sandia National Laboratories and the Institute of Paper Science to investigate this hypothesis. Prototype coated rolls were made at Sandia and tested in a pilot-scale dryer at the Institute. Energy consumption was two-thirds less and less pulp was wasted with impulse drying than with conventional paper drying.

---

[83] Information here refers to the result or product of understanding acquired through experimentation and experience that can be made available to others.

[84] Technology here refers to new applications or advances in applications of science.

Engineering estimates are that about 50% of the paper made in the United States can be dried with impulse drying (e.g., cardboard and box liners). The energy savings will be $5 per ton of paper produced, and the pulp savings will be $20 per ton of paper produced[15]. These savings are applicable to approximately 80 million tons of paper per year for total projected annual savings of $1,600,000,000.

The Institute has a proposal that has been accepted by the Department of Energy to build a pilot drying machine. If estimates are correct, impulse drying should be available to the paper industry in five years. In the absence of the plasma spray technology developed at Sandia and demonstrated by TST, scientists at the Institute estimate that it would take an additional two years for impulse drying to become commercially viable. There is also speculation that with impulse drying and lower paper costs, American paper companies will be able to compete more favorably in the world market. Although quantifiable estimates and projections can be made regarding the dollar value of the application of plasma spray in impulse drying, this application is in the technology/information category because it has not been commercialized.

Economy

Since the technology acquired was primarily the diagnostic expertise that enables the technology to be fully used, adopting the technology is not possible in the traditional sense of industry adoption[16]. This indicator, therefore, is not applicable to this technology transfer. A new business startup and jobs for ten employees are clear indicators of economic impact in Dane County, Wisconsin. The successive business users of the technology number six, including:

---

[15] See Orloff. D., (1992) "Impulse Drying of Paper: A Review of Recent Research," *Proceedings of the 14th Industrial Energy Technology Conference.*; Orloff, D. and Lindsay, J. (1993) "Advances in Wet Pressing," *Paperage* 109: 14-15.; Orloff, D. and Sobezynski, S., (1993) "Impulse Drying Pilot Press Demonstration: Ceramic Surfaces Inhibit Delamination," *Paper Technology*, 34: 24-33.

[16] The opportunity to apply for a DOE grant was available to other companies. At the time, no other company applied. Opportunities to acquire the diagnostic expertise were and are available at other national laboratories and from university-based research centers. Diffusion of the technology could have been and can be occurring from these institutions and subsequent interactions of SNL with other companies. The diffusion measured here is restricted to what has occurred as a direct result of the TST transfer.

1. automotive manufacturer,
2. bicycle company,
3. paper processing machinery producer,
4. paper mills,
5. food processing machinery producer, and
6. food processing companies.

Finally, the following cost benefit analysis quantifies the economic impact in dollar values. Final dollar values for the cost-benefit ratio are rounded to two significant figures.

Costs

Cost of producing knowledge

As discussed in Chapter 2, two approaches are used to measure costs. The first includes both the cost of producing knowledge and the cost of the transfer. The cost of producing plasma spray knowledge at Sandia National Laboratories includes the cost of capital, equipment, and labor. The fully burdened historical annual cost of the average scientific technical person at the Laboratories was taken at 0.8 full time equivalent (FTE) for each year from 1967 to 1983 and at 2.5 FTE from 1984 to 1988[17]. These annual labor costs were then converted to constant 1987 dollars[18]. The sum of these adjusted annual labor costs is $2,929,261. No facilities were constructed for this Sandia program, however, equipment over $10,000 was purchased. From 1967 to 1988, the following equipment was purchased:

---

[17] 1967-1988 is the period of time from the inception of the thermal spray program at Sandia to the beginning of the Fisher-Barton technology transfer grant research. The FTE estimates were made by the Director of the thermal spray program at Sandia.

[18] This deflator series is widely available. There is nothing obscure about how it works, and most federal salaries are tied to it. See Shires, M. (1993) "Estimating a Research and Development Price Index". Santa Monica, CA: RAND. Bureau of Economic Analysis, Department of Commerce "Implicit Price Deflators for Gross Domestic Product" (1995) Economic Indicators. Washington D.C.: Government Printing Office. March. 2.

Year	Item	Amount	GDP Defl.	Amount 1987$
1967	first spray apparatus[89]	30,000	.303	99,010
1970	plasma spray system	30,000	.352	85,227
1982	vacuum plasma system	70,000	.838	83,532
1984	laser velocimeter	150,000	.910	164,835
1986	manipulator	20,000	.969	20,640
1987	vacuum pump	12,000	1	12,000
1987	spray booth	12,000	1	12,000
	Total equipment costs			$477,244

The total cost for Sandia National Laboratories to produce thermal spray knowledge is then the sum of $2,929,261 and $477,244 or $3,406,505.

Cost of the transfer

The cost of the transfer includes the amount of government and private-sector investment allocated to the transfer. For this transfer, the government investment was the Department of Energy technology transfer grant to Fisher-Barton, Inc. for $57,000 in 1988-1989. The private-sector investment was included in the cost-benefit ratio by estimating the benefits to Fisher-Barton net of these costs[90]. The grant was converted to constant 1987 dollars, yielding $53,672 for the total cost of the transfer. The first approach, including the cost of producing knowledge and the cost of the transfer, measures total costs at $3,460,178. The second approach, including only the cost of the transfer, measures total costs at $53,672.

Benefits

Benefits are measured using actual or estimated sales, actual or estimated cost savings, and government multipliers of regional impact. For this technology transfer the benefits include: TST's net profits, regional economic impact, and successive business users' cost savings. This technology transfer occurred relatively recently. As a result, for this transfer, future rather than historical benefits are used. Benefits are projected for the period in which the competitive advantage TST's customers gain by using the technology will be sustained. Experts within each industry represented by TST's customers estimated these benefit periods. The benefit time periods range from two to three years after 1994.

---

[89] Records are unavailable to determine the cost of this apparatus, the second spray system was purchased in the 1970s. The cost of the second apparatus was arbitrarily assigned to the first spray system and adjusted to 1987 dollars.

[90] This method of estimating costs and benefits was used to protect the confidentiality of Fisher-Barton financial figures.

The data, then, are necessarily estimates, obtained from relevant experts, rather than actual market-based figures[91]. The company experts were asked to estimate profits or cost savings as though they were received in 1994. Thus all benefit estimates are point estimates in present value (1994 dollars). These estimates are summed, converted to constant 1987 dollars using the GDP deflator series, and used to calculate the cost-benefit ratios.

TST Net Profits

When a technology transferred to a number of companies in a variety of industries is studied, the individual companies' confidentiality can be maintained through aggregation of their financial data. Since this technology was transferred to one company, TST's profits would not remain confidential. To prevent full disclosure, however, TST's financial data is reported first as a five year aggregate of the investment made to transfer the technology ("pull costs"). From 1989 to 1994, TST invested $1,600,000 in salaries and equipment to acquire and implement the technical knowledge. Second, the profits are estimated by assuming that TST will recover at least five times this investment over the life of TST's use of the technology[92]. This return is taken in 1994, yielding total profits to TST of $8,000,000.

Regional Economic Impact

Regional economic benefits of a new company include increased employment of local residents and increases in spending associated with their employment. As discussed in Chapter 2, the Regional Input-Output Modeling System (RIMS II) of the U.S. Department of Commerce's Bureau of Economic Analysis are used in this report to estimate regional economic impact. Since the Department of Commerce has not developed a standard industrial classification (SIC) system code for the thermal spray industry and thermal spray does not fit easily into any existing category, an average of the output multipliers for manufacturing industries (ranging from 1.6 to 2.78) within the state of Wisconsin (2.0) was calculated[93]. Based on TST's 1994 sales of $1,000,000, the regional economic impact is $2,000,000[94]. Capitalizing this amount at 20% yields a total regional economic impact of $10,000,000.

---

[91] Estimates can be useful to establish a baseline of expected benefits for future research and to provide information to management regarding the efficiency of the transfer.

[92] This assumption corresponds to a capitalization rate of 20%. A 20% capitalization rate is conservative by most business valuation standards and corresponds to the rate mentioned in the Internal Revenue Service Revenue Ruling 68-609 (relevant to the valuation of closely-held businesses). Pratt, S. (1989) Valuing a Business: The Analysis and Appraisal of Closely Held Companies. Homewood, IL: Irwin.

Successive Business Users' Benefits

Successive business users are the customers of the business(es) with the transferred technology and, in turn, their customers. The economic benefits received by successive business users accrue as increased net profits or cost savings. Four customers of TST were willing to participate in this study. An employee within each of these four companies who would be the most knowledgeable concerning the economic benefits realized by his/her company was identified, contacted, and asked to participate by TST. These employees were assured that they and their companies would remain anonymous. Phone interviews were then conducted by this study's researchers to obtain the data on economic benefits. Among the four TST customers studied, two companies provided estimates of their own cost savings and two companies provided estimates of only their customers' cost savings (to protect their own confidentiality). The cost of each company's capital and information about anticipated increases in each company's costs were not requested or obtained.

Company #1

TST is producing ceramic coatings on integrated circuit brackets for Company #1, a domestic automobile manufacturer. These brackets are attached to the engine and transmission controls of one type of their 1994, 1995, and 1996 automobiles. Company #1 had explored alternative technologies, including insulator pads and alternative coatings. Using the best of the alternative technologies, Company #1 experienced a 1% failure rate when electric insulation was lost and the resulting electric short caused the controller to fail and the vehicle to stall. Since contracting with TST, the failure rate has been reduced to 0%, no field failures have occurred.

The project engineer interviewed at Company #1 was asked how many automobiles would benefit from the plasma sprayed brackets and what the cost savings would be for avoiding repairs on the prior 1% failed controllers. For each of the years 1994, 1995, 1996, the internal company projections indicate 500,000 automobiles will be affected. The incidence of failure would then be reduced for 15,000 vehicles (1% of 500,000=5,000 for each of three years). Based on previous experience, not accounting data, the company would save $50 in repairs per failure, net of the cost of the ceramic coating, or $250,000 ($50 times 5,000) in each of the three years 1994, 1995, 1996[95] for a total of $750,000.

---

[93] Regional Economic Analysis Division, Bureau of Economic Analysis, Department of Commerce. (1992) Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System (RIMS II). Washington DC: Government Printing Office. May 121.

[94] Although two of the four TST customer companies are located within the state of Wisconsin, their profits are included separately as benefits because the thermal spray technology is a structural change to the regional economy.

Company #2

Company #2, a domestic high-performance bicycle manufacturer[96], is purchasing ceramic coatings on their bicycle rims from TST. Company #2 anticipates that the ceramic coated rims will enhance their competitive position internationally and domestically and increase the braking ability of their bicycles. Mavic, a French competitor, has sold ceramic coated rims for two years. A domestic competitor is using a coating inferior in braking and wear resistance to plasma-sprayed ceramic.

Company #2's project engineer estimated that Company #2 could save $80 per set of rims if they had their own rims sprayed by TST instead of purchasing Mavic rims to use on their own bicycles. This cost saving figure is based on engineering estimates, since production had not begun at the time of this interview. Based on Company #2's projected sales of 30,000 bicycles per year for 1995 and 1996, Company #2 expects to save $2,400,000 per year ($80 times 30,000) in rim costs, using TST technology. The project engineer estimated that the expected market life of the ceramic-coated rims is two years at which time new bicycle technologies are expected. The total cost savings for Company #2 is then $4,800,000.

Company #3

Company #3 manufactures coater blades for paper mills. In the final stages of paper production, coater blades meter precise amounts of mineral coating onto paper to improve printability and gloss. Of the 350 paper mills in the United States, one third (≈ 117) use the type of coater blade produced by Company #3. Company #3 sells its blades to 35% of the 117 mills (≈41). It is the only domestic company selling ceramic-coated coater blades to the paper industry. These ceramic-coated coater blades advance the state of paper finishing and are more durable than conventional uncoated blades. Since they last longer than traditional uncoated steel coater blades, they reduce paper mill downtime for coater blade changes.

---

[95] This assumes that the inflation factor and discount rate cancel each other (the percent increase in the cost of repairs equals the company's cost of capital). In the absence of any additional information and given the company's history of repair cost increases, this assumption was deemed reasonable by the project engineer.

[96] The retail price range of their racing, mountain, and road bicycles is $2,500-$4,000.

Competitor coater blade suppliers are expected to provide ceramic-coated coater blades by 1996, as the coating pioneered by TST is adopted within the industry. However, TST's continual improvement of the technique may increase the expected life of the coater blades from five to twenty times. If this occurs, Company #3's paper mill customers may continue to realize cost savings beyond 1996 and Company #3 may garner a greater market share.

Based on experience and knowledge of paper mill customers, Company #3's national sales manager estimated the average net cost savings per mill due to reduced replacement time is $20,000 per year per mill. If estimates of the marketing of competitor ceramic-coated coater blades by 1996 are correct, the total cost savings realized by paper mill customers would be $820,000 ($20,000 times 41) each for 1994 and 1995, totalling $1,640,000 in customers' cost savings.

Company #4

Company #4 is a domestic manufacturer of food processing pumps. Company #4 switched from a previous vendor to purchase from TST in 1992 because TST's coating process was superior. TST sprays cermet (carbide with metal binders) and ceramic coatings on Company #4's pump components to increase their durability.

Company #4's buyer/analyst estimated that the TST-coated products reduce the failure rate by five to ten percent, or 100 fewer failures in the food processing industry per year. The analyst estimated that the average length of downtime and associated cost was 1.5 days per failure at an industry cost of $2,000 per day. The total cost savings for food processing companies would then be $300,000 per year ($2,000/day times 1.5 days times 100 failures). These savings are expected to be sustained for the years 1994, 1995, and 1996 at which time TST's technological lead will be lost to other competitors or alternative technologies. The total customers' cost savings would then be $900,000.

The sum of these economic benefits is:

TST net profits	8,000,000
Regional impact	10,000,000
Company #1	750,000
Company #2	4,800,000
Company #3 (customers)	1,640,000
Company #4 (customers)	900,000
Total Benefits ($1994)	$26,090,000
Total Benefits ($1987)	$20,689,929

Crediting SNL with responsibility for 100% of the benefits, the cost-benefit ratio for this technology transfer using both the cost of producing knowledge and the cost of the transfer is:

$$\frac{\text{Total Costs}}{\text{Total Benefits}} = \frac{\$3,460,178}{\$20,689,928} = \frac{1}{6}$$

The cost-benefit ratio for this technology transfer using only the cost of the transfer is:

$$\frac{\text{Total Costs}}{\text{Total Benefits}} = \frac{\$\ \ 53,672}{\$20,689,928} = \frac{1}{390}$$

Since TST had a vital role in achieving successful commercialization once the technology was transferred from SNL, attributing SNL with 50% of the responsibility for the benefits is a reasonable allocation of credit. With SNL at 50%, the cost-benefit ratio for this technology transfer using both the cost of producing knowledge and the cost of the transfer is:

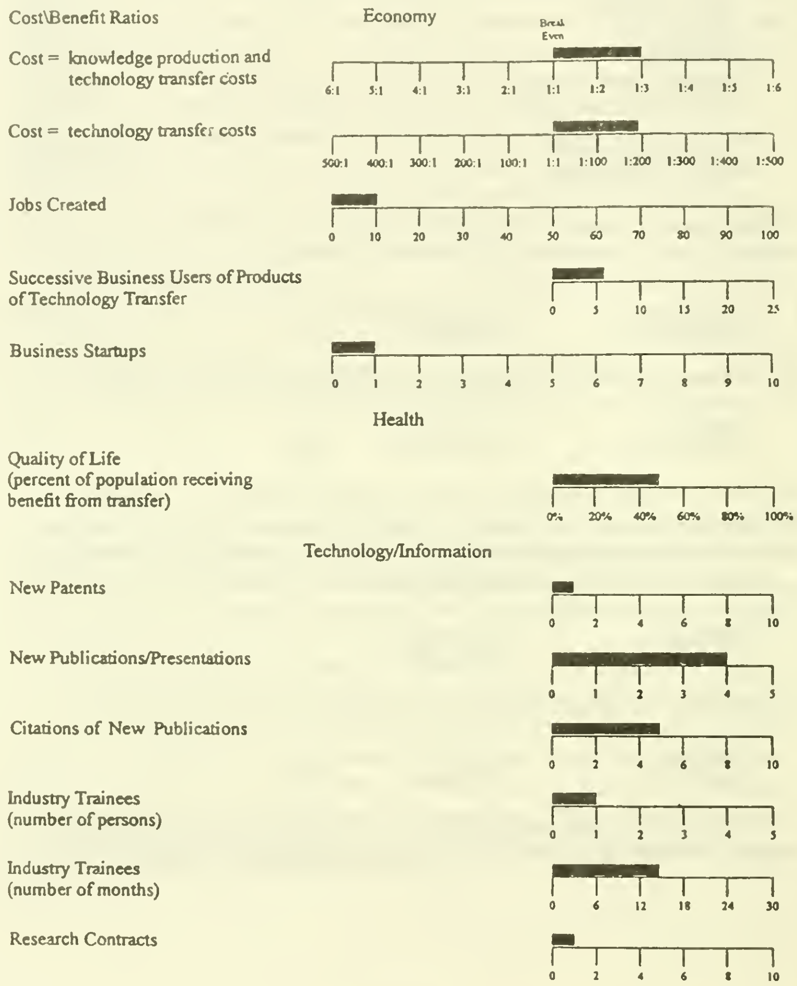
$$\frac{\text{Total Costs}}{\text{Total Benefits}} = \frac{\$3,460,178}{\$10,344,964} = \frac{1}{3}$$

The cost-benefit ratio for this technology transfer using only the cost of the transfer is:

$$\frac{\text{Total Costs}}{\text{Total Benefits}} = \frac{\$\ \ 53,672}{\$10,344,964} = \frac{1}{190}$$

The cost-benefit ratios crediting SNL with 50% are either 1:3 or 1:190 (rounded), depending on whether the Laboratories' cost of producing knowledge is considered a part of

Figure 6: Plasma Spray Impact Profile



the costs of the technology transfer[97]. The argument supporting their exclusion is that the benefits derived by society from the defense uses for which the knowledge was originally procured have been (since 1967) and continue to be received. These costs and benefits from this technology received by other Laboratories' projects or industry partnerships are not included because they are not a benefit of this technology transfer (although the Laboratories' scientists, and therefore the defense programs, did expand their expertise through working on this transfer). As discussed in Chapter 2, these costs are then sunk costs that would have occurred whether or not the transfer occurred. As such, their inclusion biases the costs upward. Nonetheless, it is clear even when these costs are included, the economic outcome of the technology transfer is positive, even though the transfer was only to one small company within the industry.

Summary

Indicators in three categories contribute to a very positive impact profile for this technology transfer. Particularly in regard to economy and technology/information, the indicators show that the transfer fostered productive, sustainable growth. TST is currently engaged in many activities and projects to develop new products and processes. Due to confidentiality concerns, these were not reported here but should be reevaluated in four or five years to enable a more complete and accurate assessment of the impact of this transfer.

---

[97] A return of over $100 for each dollar of public R&D investment is not uncommon. For example, the calculated return on the public sector investment in the breeding and varietal improvement of wheat has consistently been approximately $140. See Araji, A. (1989) "Return to Public Investment in Wheat Research in the Western United States" *Canadian Journal of Agricultural Economics* 37: 467-479. Social rates of return on investment in innovation have been estimated to range from 17% to 307%. See Mansfield, E. (1981) "How Economists See R&D" *Harvard Business Review* 98-106.

Chapter 4: Polycrystalline Diamond Compact Drill Bit Technology Transfer

Overview of Drill Bit Technology and Industry

The basic concept of drilling is the same today as it was in 7500 B.C. when, using points of sharp rock bound to slender pieces of wood or bamboo, the earliest known drilling activity occurred[98]. Today, the sharp-edged tool (drill bit) is attached to sections of drill pipe. When rotated at the bottom of the hole, the drill bit either breaks or shears away rock and other geological formations. The drill bits are rotated as one unit with the pipe (drag bit) or have attached moving parts (roller cone or rolling cutter bit)[99]. Innovation in drill bit technology takes the form of changes in drill bit design and composition materials.

A typical polycrystalline diamond compact (PDC) drill bit drill bit is composed of an 8½" drill bit body to which approximately forty PDC cutters are attached. The PDC drill bit is produced in the following sequence. A layer of synthetic diamond powder (heated and pressurized graphite) and cobalt are placed in the bottom of a ½" mold, tungsten carbide is added as a substrate, and the mold is pressurized at one million psi and heated to 1500°C[100]. The diamond crystals fuse together (forming polycrystalline diamond) and bond to the tungsten carbide forming a cutting disc (also called an insert, tip, or blank) measuring about 1/2" in diameter and 1/3" thick. A tungsten carbide cylinder is angled on one end and the cutting disc is brazed to this slanted surface forming the PDC cutter (also called a stud or post) (Figure 7). The bit body is formed by machining and the cutters are then press-fitted into the bit body (Figure 8).

The finished PDC drill bit is attached to a rotary drill pipe that revolves at between 60 and 1000 rpm. This bit drills at approximately 30 feet per hour (½ foot per minute) or higher. PDC bits are regarded as a "revolution"[101] to the drilling industry because of the significant reduction in drilling costs that is associated with this drilling rate. Since drilling crews and rigs are usually hired at daily rates, the most significant determinant of drilling cost is time. If the drilling rate is only 2-3 feet per hour, a 15,000 foot well can take weeks

---

[98] Brantley, J. (1971) History of Oil Well Drilling. Houston, TX: Gulf Publishing Company.

[99] The geology and lithology (science of the mineral constituents and stratigraphical arrangement of rocks) of the site where a well is to be dug determine the type of drill bit that will be most effective.

[100] This process is called sintering. It causes materials to fuse together by exposing them to extremely intense heat and pressure. It is not the same chemical reaction as melting.

[101] Muhleman, T. (1984) "In drilling operations, new equipment, services reduce costs and improve efficiency," *World Oil* 198:5 April 57-61.

Figure 7: Front and Side Views of a Single PDC Cutter[102]

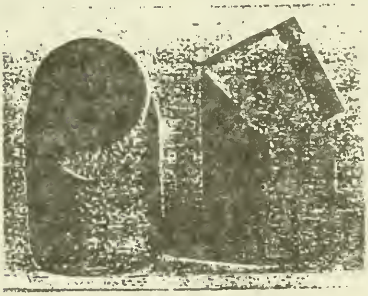
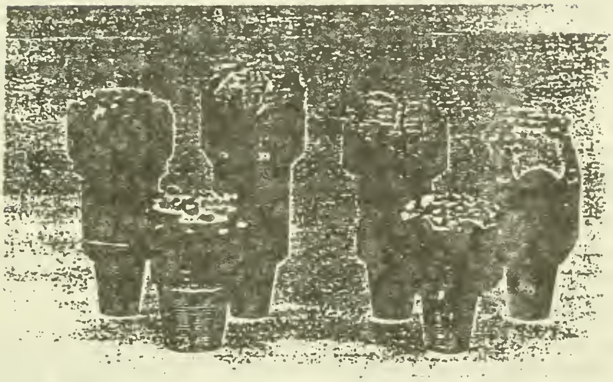


Figure 8: Examples of PDC Drill Bits



to drill. The drilling rate of PDC bits is up to ten times higher than the rate of conventional bits, radically changing the speed with which a well can be drilled from weeks to days. Total time savings for PDC usage are often reported at 50%.

---

[102] Source: Finger, J. and D. Glowka. (1989) "PDC Bit Research At Sandia National Laboratories," June Sandia Report: SAND89-0079, UC-253.

Two key features of PDC bits enable their high degree of performance increase[103]. First, PDC bits require less "weight on bit". Rotary speeds may accordingly be increased and rates of rock penetration are therefore faster. Second, PDC bits are more durable than conventional bits, reducing the number of times the bit must be replaced. Withdrawing a drill from a well (called a trip) is quite time consuming, representing a significant cost factor in a drilling project. PDC bits can shear through rock faster, are more durable, and reduce the number of trips, resulting in extraordinary time and cost savings. While PDC drill bits have been used in all formations, they "perform best in soft, firm, and medium-hard, nonabrasive formations that are not "gummy"...uniform sections of carbonates and evaporites that are not broken up with hard shale stringers, sandstone, siltstone, and shale..."[104].

The crude petroleum and natural gas industry (SIC[105] 1311) includes all industries contributing to the shipment of marketable oil and gas from the producing property[106]. Technologically, the oil and gas drilling industry remained fairly stable from the 1820s to the early 1900s. Steady technological innovation occurred from Howard Hughes' patenting of the roller cone bit in 1910 to the late 1970s[107]. The increase in oil prices by OPEC[108] and embargoes by individual oil-producing nations during the period from 1973-1985 increased pressure for greater U.S. oil production[109]. A cascade of technological advances occurred during the 1980s[110] and have continued to be refined in the 1990s.

---

[103] Allamon, J. (1982) "Conoco saves days and dollars with a new bit," *World Oil* 194:1 January 165-167. Peterman, M. (1981) "New rock bit increases rate of penetration," *World Oil* 192:2 February 1 51-54.

[104] Bourgonyne Jr., A., K. Millheim, M. Chenevert, and F. Young. (1991) Applied Drilling Engineering. Richardson, TX: Society of Petroleum Engineers. p. 192.

[105] Standard Industrial Classification (SIC)

[106] "exploration..., drilling, completing and equipping wells, operating separators, emulsion breakers, desilting equipment, and mining and extraction of oil from oil shale and oil sands, and production of gas and hydrocarbon liquids through gasification, liquefaction, and pyrolysis of coal..." US Dept. of Commerce, Office of Trade and Economic Analysis. (1994) U.S. Industrial Outlook 1994. Washington DC: Government Printing Office. S/N 003-009-00635-0. 3-1.

[107] Anderson, R. (1984) Fundamentals of the Petroleum Industry. Norman, OK: University of Oklahoma Press.

[108] Organization of the Petroleum Exporting Countries. Membership in 1973: Saudi Arabia, Iran, Iraq, Kuwait, United Arab Emirates, Qatar, Venezuela, Nigeria, Libya, Indonesia, Algeria, Gabon, Ecuador.

[109] Jones, P. (1988) Oil: A practical guide to the economics of world petroleum. Cambridge, Great Britain: Woodhead-Faulkner, Ltd.

PDC bits were a part of this cascade and represent one of the most significant advances in drill bit technology since World War II. While using natural diamonds on drill bits was not new, General Electric (GE) produced the first synthetic diamonds in 1955 and pioneered the use of synthetic diamonds on prototype drill bits in 1973[111]. The synthetic diamonds are formed when graphite is subjected to high temperature and pressure. Synthetic diamonds are used on several types of drill bits (reamers, coring bits, sidetracking bits, etc.). This study is focused on their use on polycrystalline diamond compact (PDC) drill bits, an innovation in both design and composite materials.

The PDC drill bit cutter was first tested in the laboratory and in the field (Michigan, Colorado, and Texas) in 1973[112]. The PDC drill bit was used commercially for the first time in the North Sea in 1976. General Electric marketed the first PDC cutter under the trade name Stratapax in 1977[113]. Initially, the dominant roller cone bit companies were apparently hostile to PDCs and perceived this innovation to be a direct competitive threat to their product lines[114]. Anecdotal evidence suggests that, under pressure from drill bit manufacturers and in view of the potential impact on its own investment in financing for drilling contractors, GE began to disband its PDC drill bit program.

The intervention of SNL with research and supportive funding, sustained this research during this critical period in the technology's development. The principal challenge from 1977-1980 was to find companies willing to manufacture drill bits with PDC cutters. As a consequence, small specialty bit companies and those making bits with natural diamonds were the first manufacturers of PDC drill bits[115].

---

[110] including the following: horizontal drilling within one formation, coil tubing, improvements in metallurgy used in pipe and casing, drill bits, MWD (measurement while drilling) systems, bit hydraulics, mud chemistry improvements, down hole motors for directional drilling. The task of identifying the individual impact of each technological advance on the oil and gas drilling industry is complex because of this.

[111] Madigan, J. and R. Caldwell. (1981) "Applications for Polycrystalline Diamond Compact Bits From Analysis of Carbide Insert and Steel Tooth Bit Performance," *Journal of Petroleum Technology* 1171-1179.

[112] Ibid. Madigan and Caldwell (1981).

[113] "Diamond composites used in new bits," (1977) *Oil and Gas Journal* 75:16 April 18 71-72., Slack, J. and J. Wood. (1981) "Stratapax bits prove economical in Austin Chalk," *Oil and Gas Journal* 79:34 August 24 164-165+.

[114] Feenstra, R. (1985) "Diamonds are becoming more important to drilling technology," *Oil & Gas Journal* 83: December 30 131-136.

From 1980 to 1982, PDC bit failure was unacceptably high for a host of technological reasons[116] and the economic viability of PDC bits was still in question. It still was not clear where--geologically--PDC bits could be fruitfully used since the drilling industry tried out the new bits with considerable success in parts of Texas, Louisiana, and the North Sea[117] and with rather stunning technological failures in other regions[118]. As one manufacturer advised at the time, "If you remember nothing else about what I have to say, Stratapax or polycrystalline product is very formation sensitive and it takes tender loving care"[119]. Early commercial reports from the field were mixed as PDC bits had an immediate cost impact in the southwest and central U.S. and the North Sea[120] and yet, rates of penetration and time savings were often not good enough to compensate for the much higher cost of PDC bits relative to conventional steel roller cone bits. The cumulative result of these problems was quite threatening to the market success of the bits. Word of drilling problems spread rapidly through the industry and few drilling contractors were willing to try PDC bits. In a short period of time, the bit had earned a "bad reputation".

However, this two year period saw rapid improvements in PDC bit design and operator know-how. Indeed, Conoco reported a doubling in bit life and rates of penetration from 1980 to 1981[121]. The 1980-1982 period seems to be a good benchmark for the emergence of PDC bits as a viable product with a real commercial market. By 1982, the demand for PDC bits reached 4,800 units for a net sales value of $72 million[122]. About 70% of the sales were to U.S. drillers, 13% to the North Sea, and the remainder dispersed worldwide.

---

[115] Personal interview, former GE official.

[116] De Boisblanc, C. (1985) "Water mud gives advantages with PCD bits." *Oil & Gas Journal* 83: April 1 134+., Dennis, M., J. Kelety, and D. Clark. (1987) "Advances in PDC bits Part 1," *Oil & Gas Journal* 85: September 14 52+., Dennis, M., J. Kelety, and D. Clark. (1987) "Advances in PDC bits Part II," *Oil & Gas Journal* 85: September 14 62-64+.

[117] Ibid. Slack and Wood (1981).

[118] "Diamond shear bit panel," (1982) *Oil & Gas Journal* 80: September 27 176-178+.

[119] "Diamond shear bit panel," (1982) *Oil & Gas Journal* 80: October 4 80-82.

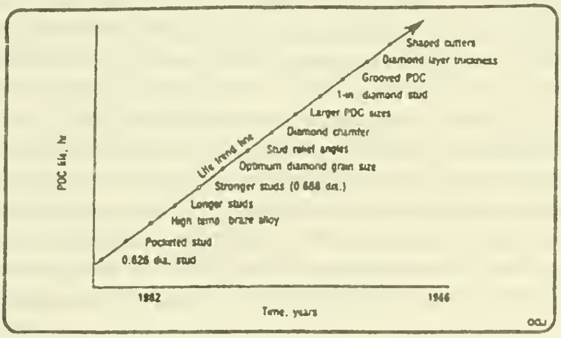
[120] "Diamond shear bit panel," (1982) *Oil & Gas Journal* 80: October 4 80-82., Ibid. Allamon (1982).

[121] Ibid. Allamon (1982).

[122] "Diamond shear bit panel," (1982) *Oil & Gas Journal* 80: October 4 80-82.

From 1982-1986, a substantial number of technological improvements were made to overcome performance problems of the first generation of PDC bits (Figure 9). During this period, the market for PDC bits settled down. First, roller bit manufacturers took up production of PDC bits in a major way. Second, demand increased steadily once the technological flaws of the first generation bits were corrected, know-how accrued, and bits were developed that could drill a wider variety of rock.

Figure 9: Improvements in PDC Bits 1982-1986[123]



When OPEC reduced prices in 1985, the domestic oil industry was undercut and began a steady decline in production[124]. The decline in domestic production has caused industry restructuring. Traditionally, oil companies hired drilling contractors to drill wells and drilling contractors subcontracted out for the provision of the services and equipment needed to drill wells. To survive in the depressed domestic market, the U.S. industry is moving toward a total service company concept in which the oil companies will finance and hire a total package of drilling, services, tools, and materials[125].

---

[123] Source: Ibid Dennis, M., et al. (1987) "Advances in PDC bits Part II".

[124] OPEC's continued influence along with: the influences of worldwide economic growth; international investment in production; oil and gas production and export from developing countries and republics of the former Soviet Union; and environmental regulations and concerns (Oil producers are not required to comply with as many environmental regulations to obtain foreign oil as they are for domestic oil. As a result, oil from the North Sea, Southeast Asia, and South America has become increasingly available, further suppressing the production of domestic oil.) are expected to impact the markets for oil and gas through 1998. Domestic crude oil production is expected to continue to decline while consumption will increase, creating greater import dependency in the U.S.. Source: U.S. Dept. of Commerce, Office of Trade and Economic Analysis. (1994) U.S. Industrial Outlook 1994. Washington D.C.: Government Printing Office. S/N 003-009-00635-0. 3:1-6.

Accordingly, the number of PDC bit manufacturers has steadily declined. In the late 1970s, there were about 15-18 small specialty producers[126]. By the mid 1980s, production had shifted to a dozen major roller cone and specialty bit manufacturers[127]. Now, there are fewer than 10 key PDC bit suppliers due to ongoing mergers and acquisitions in the industry[128]. The four primary PDC bit manufacturers (accounting for 90% of sales) are Hughes Christensen[129], Hycalog, Security DBS, and Smith International[130].

Even with the decline in domestic production, PDCs remain an important technological advance. Today, as one industry official put it, "PDC bits are now widely accepted and used in the drilling industry. Their range of applicability has expanded greatly, and even though they are still used primarily in soft formations, these represent some of the most active drilling sites"[131]. Experts believe that PDC bits are now used to drill one-third of all oil well footage[132], and sales of PDC bits by U.S. manufacturers are estimated at

---

[125] Restructuring is relevant because the buy outs and takeovers of the smaller tool (including PDC) companies by large service companies decrease competition and incentives for innovation. Roller cone bits have a higher profit margin than PDCs and they are less durable, requiring more bits per well. This provides a profit motive for the large service companies to emphasize roller cone over PDC bit use. The four large companies moving toward the total service company are: Smith International, Hughes Christianson, Reed Hycalog, and Security DBS. (Personal interview, former GE employee February 7, 1995.)

[126] "Diamond shear bit panel," (1982) *Oil & Gas Journal* 80: October 4 80-82., Feenstra, R. (1985) "Diamonds are becoming more important to drilling technology," *Oil & Gas Journal* 83: December 30 131-136.

[127] "Drill Bit Classifier," (1985) *World Oil* 199: September 45-58.

[128] For example, Diamant Boart (from Belgium) bought out U.S.-based Stratabit, forming DBS. DBS was recently acquired by Security Dresser, forming Security DBS.

[129] Hughes Christensen is also the result of a chain of mergers and acquisitions: Baker Tools bought Hughes Tools in the early 1980s, forming Baker Hughes, which acquired Eastman Christensen in the early 1990s, forming Hughes Christensen.

[130] Paine Weber Consulting. (1995) "Report to the Camco Group".

[131] Interview with officials of the International Association of Drilling Contractors (1995).

[132] Interview, former GE engineer (1995).

$262 million in 1995[133].

Polycrystalline Diamond Compact Drill Bit Technology Transfer[134]

In 1969 the Director of Exploratory Development in Nuclear Weapons at Sandia National Laboratories initiated a study of the energy industries within the Exploratory Development Department. The intent of the study was to identify the most important research and development needs within these industries, determine if Sandia National Laboratories had the expertise to provide useful assistance, and apply the available resources of Sandia National Laboratories to the targeted technologies. The Director was concerned about the security of the oil supply to oil consuming countries for national defense reasons prior to the OPEC oil embargo. To accomplish this task, approximately nine Sandia managers and scientists began working part-time on this project. They met with representatives from oil, gas and geothermal companies and attended briefing sessions conducted by these companies. Three drilling technologies were targeted by this study: drill tools, mud circulating systems, and well logging tools.

At the time, industry structure created economic disincentives that dampened technological progress in the oil drilling industry. The oil drilling industry consisted of three types of companies: production, drilling, and service. Production companies were very large and few in number; drilling companies small and very numerous; and service companies small, diverse, and numerous.

Production companies paid $200,000 per day to drill a well (in 1970 dollars) whether the well was successful or not. The competition for drilling contracts with the oil producers was very fierce. The drilling and service companies that obtained contracts were not operating with a large enough profit margin to invest in research and development. For example, one company representative told a Sandia manager, "Research, to my company, is a project that doesn't have to show a profit for nine months"[135]. The expertise, resources, and incentive to substantially advance drilling technology did not exist within the industry structure at that time.

Once SNL had targeted the technologies, SNL obtained the active participation of industry by establishing Industry Advisory Committees. The members of these Committees were representatives of all industries (including producers, drilling, and service companies) willing to participate. The Committees reviewed the work conducted at SNL at first on a quarterly basis and later semi-annually. The interaction with industry created a network of contacts for information to flow freely between SNL and the oil drilling industry.

---

[133] Paine Weber Consulting. (1995) "Report to the Camco Group".

[134] Information for this section was primarily drawn from focus group and personal interviews conducted in 1994 and 1995 with program managers at Sandia National Laboratories, universities, and companies in the various industries that were involved in this research.

[135] Personal interview, SNL manager (November 3, 1994).

The drill tool targeted for work was the polycrystalline diamond compact drill bit produced by General Electric (GE). The PDC drill bit was selected because the high temperature environment in geothermal wells caused serious malfunction of drill bits with moving parts (ie., roller cone bits). Since the PDC bit had no moving parts, it appeared to be a good candidate for drilling geothermal as well as oil wells. The Geothermal Division of the Department of Energy (DOE) had contracted with GE to study the feasibility of PDC drill bits for geothermal use. In 1977, the responsibility for drilling technology development undertaken by DOE was transferred to SNL with funding sustained by the Geothermal Division of DOE.

At the time SNL became involved, GE had attempted to test PDC bits in the field. The PDC drill bits drilled two to three times faster than roller cone bits, the conventional technology at that time (1977), and came apart (20-30% failure rate) when they hit hard formations in the field tests. Since the PDC bit is a drag style bit and is in continuous contact with the rock, it generates high heat in operation. The combination of high heat and harsh environment created two problems: the bond between the tungsten carbide substrate and the post came apart (catastrophic failure) and the cutter fractured and chipped off (spalling). In addition, proper field operating conditions (drilling rotation speeds, weight on bit, cleaning fluids, etc.) were unknown.

Multiple organizations contributed to solving these problems, especially the oil companies and bit manufacturers. Sandia played a critical role by conducting fundamental research on bit mechanics, hydraulics, and proper field operating conditions (including: rock-cutting mechanisms, cutter temperatures, wear mechanisms, bit hydraulics, stresses, and multiple cutter interaction) and disseminating the results of its research. SNL's contribution included identification of the following reasons for the PDC problems. First, the braze that GE was using to attach the cutter to the post was poorly manufactured. The quality control on the brazing process was inadequate, enabling cutters to be marketed that were not properly attached. SNL scientists and engineers informed GE of the problem and developed an alternative method, diffusion bonding, to solve it. GE chose to correct the problem using an alternative brazing technique and increasing its quality control.

The fracturing of the cutter itself was caused by the wear rate. Three solutions were developed by SNL to deal with this problem. First, SNL established what is now a standard design parameter of the bit (a 20° back-rake angle). The second was to create a method to enable the optimal placement of the cutters on the bit to equalize the wear of the bit. The method was in the form of a computer program to enable bit manufactures to optimally place the desired number of cutters on the bit. The initial computer program (STRATAPAX-released in 1982) and final revision of the program (PDCWEAR-released in 1986) were widely dispersed and used within the industry. Smith International cites Sandia's computer code in its company trade brochures[136].

In addition, PDCWEAR was also instrumental in an important innovation in bit design. Building upon Sandia's code, Amoco developed its own software package and introduced the "antiwhirl" bit to the marketplace in 1990. The antiwhirl bit design reduces the amount of dynamic force produced during the drilling process, resulting in increased bit life and less fatigue in the drilling apparatus. The antiwhirl bit has been somewhat of a "sensation" in the industry, and has generated a new round of PDC bit innovations.

The third solution required clearer understanding of the wear rates of the PDC cutters. SNL research found that once a certain temperature was reached, there was catastrophic wear of the cutters. This information enabled the industry to know that this type of bit would not work for geothermal wells. It also directed the scientific inquiry to investigate the hydraulics within the well, to ensure that the optimal cooling of the bit was achieved. The design developed by SNL for nozzle layout on the bit to achieve optimal cooling was adopted and used by bit manufacturers[137].

SNL is also credited with having "saved" the PDC bit by funding: 1) research at General Electric when pressure was being exerted to end GE's program; 2) the manufacture of PDC bits by small specialty companies; and 3) university research programs for laboratory and field tests of the bit. In an industry article summarizing bit advances and breakthroughs from 1981 to 1986, almost half of the citations are to Sandia's work[138]. In interviews, many officials openly credited Sandia for the progress in PDC bits, and pointed out that it was the publicness of this effort that made a difference[139].

---

[136] Company product literature. Smith International.

[137] Finger, J. and D. Glowka (1989) "PDC Bit Research at Sandia National Laboratories" Sandia Report SAND89-0079.

[138] Dennis, M., J. Kelety, and D. Clark. "Advances in PDC bits," (1987) *Oil & Gas Journal* 85: September 14 62-64+.

The editor of *Drilling Engineering*, the journal of the Society for Petroleum Engineers, picked an article by Sandia engineers as "best of issue," and praised it for its comprehensive, detailed explanations of PDC bit wear, load, and temperature[140]. As one industry expert put very simply, "everyone used papers from the labs at Sandia"[141]. Sandia's senior engineer on the PDC bit program was nominated by an industry official for his work on PDC bits: "From my point of view as a drill bit manufacturer, I think the research which .... has presented at SPE meetings the last several years represents some of the most important scientific work related to drilling technology. I would like to nominate him for the 1985 SPE Drilling Engineering Award"[142].

In sum, SNL's R&D efforts from 1973-1986 contributed several important elements to the PDC bit's success in the marketplace. First, it is unlikely that the bit would have come to market when it did, or overcome industry resistance, in the absence of SNL involvement. The importance of this timing should not be underestimated. If this bit had been re-introduced even five years later, it would have undoubtedly met with market failure. Since PDC bits were re-introduced right as a drilling boom took off, the demand for bits compensated for their early negative reputation. If the market re-introduction of the bit had coincided with the subsequent drilling "bust," the inherent conservativism of the industry probably would have prevailed.

Second, one of the most important benefits of SNL R&D was psychological. Sandia helped establish that the problems plaguing the bits could be designed out or alleviated with proper operating techniques. Past bit failures were no longer seen as reflecting intrinsic limitations of PDC materials or drilling mechanics. SNL established a scientific foundation for further research, providing both encouragement and direction to the oil drilling industry. The resulting reduction in industry resistance to the bit stimulated a fresh round of private R&D and market growth.

Third, the knowledge and know-how created by SNL's R&D was the grist for the commercial innovation mill during the early-to-mid 1980s. Again, the significance of this should not be underestimated. Since growth in market demand for the bit is clearly tied to technological progress[143], the overall market success of PDC bits can be directly attributed to Sandia's contributions during the 1980s. Finally, SNL's R&D pushed the innovation cycle of PDC bit technology with its PDCWEAR code. The modelling power of this code is substantial, and will likely continue to fuel the ongoing performance improvements and expanded applications of this bit.

---

[139] Interviews with officials from Hughes Christensen and from Amoco Production Co. and experts at the University of Tulsa.

[140] Millheim, K. (1986) "Executive Summary," *SPE Drilling Engineering* June p.170.

[141] Interview with officials at GE Superabrasives.

[142] Letter from Reed Tool Company (currently Reed-Hycalog) to Sandia National Laboratories.

Impact of Polycrystalline Diamond Drill Bit Technology Transfer

Historical data from Sandia scientists and engineers, experts from the oil drilling industry, drill bit industry, synthetic diamond industry, industry associations, university scientists, government experts, and published records were used to develop the impact profile for this technology transfer. Figure 12 (page 77) represents the impact of the transfer of Sandia National Laboratories' contribution to the successful commercialization of the polycrystalline diamond (PDC) drill bit in regard to health, environment, technology/information, and economy.

Health

Drilling oil wells has been and is a hazardous occupation. For example, the difference between the workmen's compensation risk ratings of the average clerical worker and the average oil drilling worker illustrate this (Table 4).

Table 4: Comparison of workmen's compensation ratings[144]

	Assigned Risk	Voluntary Risk
clerical (code 8810)	$ .64/$100	$ .35/$100
oil drilling (code 6235)	$30.52/$100	$16.13/$100

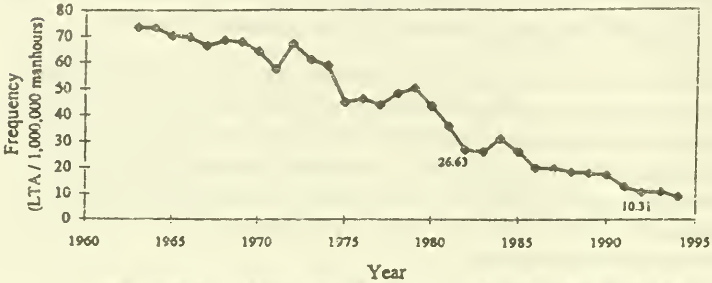
As previously mentioned, tripping a well is costly because it is a time-consuming, tedious job that can take eight to sixteen hours. It is also dangerous, providing opportunity for accidents. With the advent of a new technology (the PDC bit) that reduces the times a potentially hazardous operation (tripping a well) has to be performed, the impact on the accident and fatality rates should be observable. As shown in Figures 10 and 11, the lost time accidents and fatalities in the drilling industry have declined considerably.

---

[143] Interview with officials from Amoco Production Co.

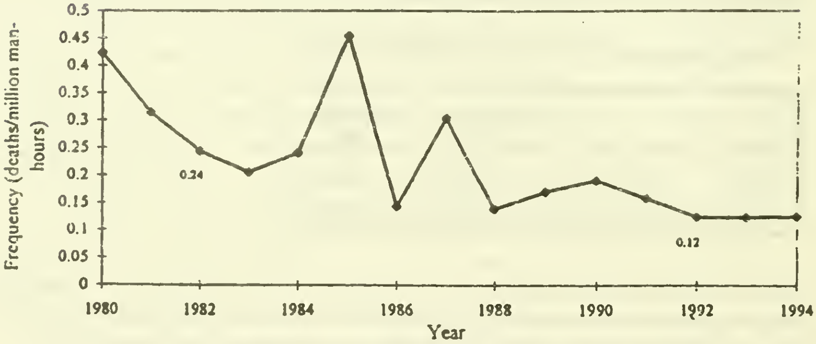
[144] Source: National Council on Compensation Insurance (NCCI). (1994) Scopes Basic Manual Classification. Boca Raton, FL: NCCI. (December 1).

Figure 10: Frequency of Lost Time Accidents (1963-1994)



Source: International Association of Drilling Contractors (IADC) Accident Statistics Program Year End Reports.

Figure 11: Frequency of Fatalities (1980-1994)



Source: International Association of Drilling Contractors (IADC) Accident Statistics Program.

Oil well drilling technology had remained fairly stable from about the 1930s to the 1970s. During the late 1970s many innovations were introduced that also affected the drilling of wells such as: horizontal drilling, coil tubing, MWD systems, and improvements in the metallurgy of drill pipes. Since the accident statistics do not identify causes, it is difficult to apportion the responsibility for the reduction in accidents. In addition, industry officials indicated that during the period when the U.S. oil drilling industry was booming (1979-1985), the shortage of oil drilling workers was resolved by recruiting and placing workers on drilling rigs with little or no training. The accidents and deaths during this period could have resulted from both new and experienced drilling workers having to learn and adjust to new technologies. The gradually declining accident rate can then be a result of the combination of improved technologies and increased emphasis on training.

The data to quantify the relationship between the decreasing frequency of lost time accidents (LTAs) and fatalities and the implementation of the PDC are not available (independent variables such as age of workers, number of trips, amount of worker training, worker experience, etc.). However, the decreasing trend is observable in averages before the oil boom, upon implementation during the boom, and after the boom[145]:

	Range	Average LTA Frequency
pre oil boom/preimplementation	1976-1978	45.70
oil boom/preimplementation	1979-1981	42.83
oil boom/post implementation	1982-1984	27.77
post oil boom/ post implementation	1986-1988	19.17

PDC bits do contribute to this reduction by reducing the opportunities for accidents through reducing the number of trips and reduced well completion time. PDC bits are used to drill approximately one third of the total feet drilled. The conservative allocation of credit of 17% of this reduction to PDC bits is based on the 2-3 fold increase in rate of penetration using PDC bits[146]. This allocates one sixth of the reduction in LTA for the period from 1982 to 1992 in the following manner[147]:

---

[145] Since accident rates are variable, trends are usually calculated using averages.

[146] The formulae for this calculation are shown in Appendix A.

[147] A benefit period from 1982-1992 has been derived by studying the commercialization of the PDC drill bit and 50% credit is assumed based on discussions with industry experts and the perspective that the Laboratories and industry were equal partners in the development of PDC technology.

Year	Actual Annual Manhours	Actual LTA	LTA Freq.	Estimated Annual Manhours	Estimated LTA	PDC LTA Decrease	SNL Contrib.
1982	204,768,816	5452	26.63	215,212,025	5730	278.05	139.03
1983	180,411,050	4660	25.83	198,812,977	5135	475.32	237.66
1984	199,147,728	6150	30.88	229,617,330	7090	940.95	470.48
1985	182,828,421	4750	25.98	220,125,418	5719	969.00	484.50
1986	118,708,246	2345	19.75	148,978,848	2942	597.98	298.98
1987	101,819,986	1989	19.53	127,784,082	2496	507.19	253.59
1988	129,985,221	2369	18.22	163,131,452	2973	604.09	302.05
1989	141,039,952	2517	17.85	177,005,139	3158	641.83	320.92
1990	147,010,350	2518	17.13	184,497,989	3160	642.09	321.05
1991	145,533,016	1813	12.46	182,643,935	2275	462.32	231.16
1992	152,977,222	1577	10.31	191,986,413	1979	402.14	201.07

Total SNL contribution to number of accidents prevented 3260.48

estimated manhours = {(actual manhours)(1 - % PDC contribution adjusted by arithmetic progression for implementation[148])} + {[2.5] [(actual manhours)(% PDC contribution adjusted by arithmetic progression for implementation)]}

estimated LTA = $\frac{\text{(estimated manhours)(LTA frequency)}}{\text{1M manhours}}$

estimated reduction due to PDC = (estimated LTA) - (actual LTA)

SNL contribution to reduction = (estimated reduction due to PDC)(.50)

The sum yields a total SNL contribution of approximately 3260 lost time accidents prevented. The allocation of one sixth of the reduction in fatalities for the period from 1982 to 1992 is as follows:

estimated manhours = {(actual manhours)(1 - % PDC contribution adjusted by arithmetic progression for implementation)} + {[2.5] [(actual manhours)(% PDC contribution adjusted by arithmetic progression for implementation)]}

estimated fatalities = $\frac{\text{(estimated manhours)(fatality frequency)}}{\text{1M manhours}}$

estimated reduction due to PDC = (estimated fatalities) - (actual fatalities)

SNL contribution to reduction = (estimated reduction due to PDC)(.50)

---

[148] The implementation percentages for PDC contribution are as follows: 1982-0.034, 1983-0.068, 1984-0.102, 1985-0.136, 1986-1992-0.17.

Year	Actual Annual Manhours	Actual Fatalities	Fatality Freq.	Estimated Annual Manhours	Estimated Fatalities	PDC Fatality Decrease	SNL Contrib.
1982	204,768,816	50	.24	215,212,025	52	2.6	1.27
1983	180,411,050	37	.21	198,812,977	40	3.8	1.88
1984	199,147,728	48	.24	229,617,330	55	7.3	3.67
1985	182,828,421	83	.45	220,125,418	99	16.9	8.46
1986	118,708,246	17	.14	148,978,848	21	4.3	2.16
1987	101,819,986	31	.304	127,784,082	38	7.9	3.95
1988	129,985,221	18	.14	163,131,452	22	4.6	2.29
1989	141,039,952	24	.17	177,005,139	30	6.1	3.06
1990	147,010,350	28	.19	184,497,989	35	7.1	3.57
1991	145,533,016	23	.16	182,643,935	28	5.9	2.93
1992	152,977,222	19	.12	191,986,413	23	4.8	2.42

Total SNL contribution to number of fatalities prevented 35.7

The sum yields a total SNL contribution of approximately 36 fatalities prevented. Thus, in this transfer, a reduction in drilling accidents and worker lives saved/lost are asserted to represent a real decrease in accidents and worker lives saved/lost related to the replacement of an existing technology.

The increase/decrease in longevity related to this technology transfer, although potentially existent, would be fairly small and highly speculative. The number of people at potential risk is the number of people directly working in oil and gas well drilling[149] which was 36,000 for 1994 (approximately half or 18,000 for oil well drilling alone)[150]. A reduction in risk has occurred for .013% of the population[151]. Therefore, for this transfer of technology, the avoidance of risk associated with these technological improvements is not readily quantifiable because the extent of risk to the general population is very small. This indicator is intended, however, to capture reductions or increases in quantifiable, known risks to the general population rather than unknown or remote risks. Therefore this indicator is not applicable to this technology transfer.

---

[149] Oil and gas drilling statistics are reported together because, geologically, oil and gas are often found together.

[150] This figure was provided by the International Association of Drilling Contractors. It is derived by multiplying the number of wells known to be drilled in the year times the number of workers required to drill a well. Figures reported to the Bureau of Census are aggregated at a much higher level (2 digit SIC) and therefore include workers engaged in many other oil and gas industry activities other than drilling.

[151] Although the risk to the general population is quite small, the benefits to those affected are very large. In addition, the savings realized in insurance and liability decreases indirectly affect the general population through reducing the overall cost of oil and gas drilling.

The quality of life indicator, however, is applicable to this technology transfer because of the effect in reducing costs in oil well drilling. Although OPEC pricing and other influences overshadowed the impact of this technology, by reducing the costs of production, the profitability of the oil industry is enhanced. Since the health and vitality of the oil industry is important to the national economy, 100% of the population is indirectly benefitted. In addition, assuming the reduction in the cost of drilling is passed on in the price of gasoline (if even minutely), 99% of the population is benefitted by lower prices.

Environment

The drilling of wells can require environmental remediation[152]. It is, however, unrelated to the introduction of this technology and would be required if an alternative drill bit is used. The manufacture of synthetic diamonds does not create any toxic water, air, or soil pollutants or waste products. The manufacture of the PDC cutters uses cobalt in the tungsten carbide substrate. However, the majority of conventional roller cone bits are also manufactured with tungsten carbide, using ten times the cobalt for each roller cone bit as is used for the cutters for one PDC bit[153]. Since PDC's replace roller cones in about a 1:3 ratio, a reduction in the amount of cobalt used has occurred. In either case, precautions are taken to minimize exposure of manufacturing workers.

In the early years, fluxes and industrial solvents were used to clean the components before brazing and cadmium was used to improve alloy flow in the brazing process (for both PDC and conventional bits) creating volatiles such as boric acid fumes that could create respiratory problems for workers and potential water pollutants[154]. The airborne pollutants were captured in exhaust and air filtration systems and silica deposits and potential water pollutants were captured in wash tanks and disposed of according to EPA guidelines. In approximately 1990, cadmium was eliminated and aqueous detergents for degreasing replaced industrial solvents.

---

[152] There are environmental regulations for the disposal or treatment of oil-based muds for drilling. Since these muds are used with both PDC and roller cone bits for formations that swell in contact with water-based muds (such as shale), the need for this remediation is not exclusively created by the use of PDC bits (as is also the case with restoring land sites).

[153] Personal interview, PDC cutter manufacturer.

[154] EPA primary drinking water standards of 0.005mg/l MCL (maximum contaminant level) for cadmium (effective date 30 July 1992) and 0.2mg/l MCL for trichloroethane.

The manufacture of roller bits and PDC drill bit bodies generate the same wastes. Given that PDC bits reduce the number of bits used by replacing roller cone bits in ratios from 1:3 to 1:7, fewer bits are manufactured and less waste is therefore produced. PDC bits are inherently more energy-efficient in drilling than are roller bits. Although PDC bits generally require approximately three times more drilling torque than roller bits for a given weight-on-bit, penetration rates with PDC bits are often 2-10 times higher than with roller bits. Consequently, the energy required to drill an interval with PDC bits may be as low as 30% (3/10) of that required to drill the same interval with roller bits. This, in large part, is due to the fact that PDC bits generate much larger rock chips than do roller bits; therefore less energy is expended in crushing the rock into pieces that are smaller than necessary to flush them out of the borehole. Therefore, the environmental impact of PDC bits is a decrease in the volume of pollutants created[155] and a decrease in energy usage by using the new technology in approximately one third of drilling footage.

Technology/Information

Thirty-four published journal articles and 18 conference presentations made the SNL PDC research available to the public. Citation analysis yielded 68 citations of these articles. Although copyrights were not sought or issued for STRATAPAX or PDCWEAR, technology[156] increased as these codes were made available to the public and any company had free access to their use. These codes enabled one incremental improvement of the PDC bit, the placement of the inserts or cutters on the bit body. SNL solved two problems: the spalling and failure of the bond between the inserts and the post and the catastrophic-wear problem. In addition, a consortium of PDC drill bit and synthetic diamond manufacturers, university researchers, and SNL scientists and engineers have recently (1994) entered a contract to further advance PDC bit development[157].

---

[155] Since the number of PDC or roller bits manufactured and the number of pollutants and quantity of each type generated in manufacturing is not available, no quantification of this reduction is included.

[156] Technology here refers to new applications or advances in applications of science. For example, the basic sciences of fluid mechanics, heat transfer, and mechanics of materials were applied in the computer codes SNL developed to solve the problems of placement of cutters and catastrophic-wear.

Economy

Although the restructuring of the oil industry for worldwide economic reasons unrelated to the introduction of this technology overshadow the extent of economic impact that this technology had, the impact is real and will be quantified using the following estimates. GE and its patent lessees, De Beers and Sumitomo, were initially the only suppliers of PDC inserts/cutters[158]. By 1984 two additional synthetic diamond manufacturers, Megadiamond and Valdiamant, were in business. GE's patent expired in 1991, fostering more business startups. In 1995, there are nine synthetic diamond suppliers: GE, De Beers, Sumitomo, Megadiamond, Dennis Tool, U.S. Synthetics Corp., Ilgin, Phoenix Crystal, and Novatech, all manufacturers of PDC inserts/cutters. The PDC insert/cutter market has grown from approximately $30M in 1984 to $45M in 1994. Industry experts estimate[159] that, in 1995, 250-500 workers are employed in the domestic manufacture of PDC inserts/cutters for PDC drill bits. Using an average of 375, a simple arithmetic progression was used (with 1976 as the base year of 0 workers) to derive 315 workers in 1992. Crediting SNL for one half of those workers[160], 158 jobs resulted from this transfer.

During the oil boom years, in addition to the existing large drill bit companies already producing roller cone bits and PDC bits, approximately 16 PDC drill bit manufacturer business startups occurred, responding to the increased demand. At minimum, estimating four to five jobs per business[161], 64 to 80 jobs were created. However, due to changes in the oil industry, only about twelve drill bit manufacturers remain in business. Four of the twelve are the products of mergers and acquisitions among the original large drill bit companies and they supply 90% of domestic PDC drill bits.

---

[157] Glowka, D. and D. Schafer. (1993) "Program Plan for the Development of Advanced Synthetic-Diamond Drill Bits for Hard-Rock Drilling," Sandia National Laboratories September SAND93-1953 UC-253.

[158] PDC manufacturers supply either the insert or the cutter according to the PDC drill bit manufacturer preference. Approximately 50% of PDC drill bit manufacturers prefer to assemble the cutter in-house, 50% purchase the preassembled cutters.

[159] Polycrystalline Diamond Producers Association and PDC industry experts.

[160] The allocation of 50% of the credit for benefits derived from the transfer acknowledges the partnership between the laboratories and industry that must be active for commercialization to succeed.

[161] Estimates by drill bit manufacturing industry officials.

The manufacture of PDC drill bits is more labor-intensive than conventional roller cone bits and involves greater technical training and skill. Today, based on industry experts estimates, 750 workers are estimated to be employed in the domestic manufacture of PDC drill bits in 1995. Using 750 workers, a simple arithmetic progression was used (with 1976 as the base year of 0 workers) to derive 633 workers in 1992. Crediting SNL for one half of those workers, 317 jobs resulted from this transfer. Summing the jobs for the two industries, a total of 475 domestic jobs were created[162].

Although a loss of sales of roller cone bits resulted in a loss of roller cone manufacturing jobs, as noted in the discussion in Chapter 2, it would misrepresent the true impact to reduce benefits by the effects of the replacement of the old technology. Thus, the reduction is not commonly included in assessments of the impact of new technology and will not be included here[163].

By number of companies, ten drill bit manufacturers currently produce PDC drill bits, an 80% industry adoption rate. There are four successive business users of this technology:

1. PDC drilling contractors,
2. oil companies,
3. mining companies[164], and
4. environmental cleanup[165].

Finally, the following cost benefit analysis quantifies the economic impact in dollar values. All dollar values were rounded to two significant figures in the final cost-benefit ratios.

Costs

Two approaches to measuring costs were discussed in Chapter 2. Since the reason for producing the PDC knowledge was to transfer it to industry, a distinction is not made here between the costs to produce the knowledge and the costs to transfer the technology. The same funds were simultaneously used to develop the knowledge and transfer it to industry through the contracts and open communication that were ongoing throughout the project. Therefore, all SNL costs related to this technology are referred to generically as costs[166]. The costs include the cost of capital, equipment, and labor. Sandia actively researched PDC bits from 1973-1986. The labor costs include the costs of SNL labor and the costs of contracts for research with industry and universities during that time period. The following allocations were made for four contracts for PDC drill bit research[167]:

---

[162] This number is gross, not net, new jobs.

[163] Importantly, although some economic displacement occurred, the new jobs were created domestically and the PDC industry was retained.

[164] PDC bits are currently being used in mining in two applications: 1) to make 2-3" drill and blast holes for the placing of explosives and 2) to drill 1" roof bolt holes for use in attaching plates to the face of the mine to stabilize the mine roof.

[165] PDC drill bits are used to ream out pipe that has been sealed by deposits. For example, they used to clean out pipes in chemical plants and water supply systems. Source: Personal interview, PDC cutter manufacturer.

Year	Contractors	Amount	$1987
1976-1977	#1 GE	106,000	195,933
1977-1978	#2 BYU[168]	15,000	25,817
1977-1978	#3 DRL[169]	20,000	34,423
1977-1978	#1 GE	19,000	32,702
1978-1979	#1 GE	160,000	254,169
1979-1980	#3 DRL	20,000	29,133
1979-1981	#1 GE	28,000	38,853
1980-1981	#3 DRL	20,000	26,560
1982-1983	#4 TU[170]	50,000	58,480
1983-1984	#4 TU	50,000	56,117
		Total	752,189

The total contract cost for PDC drill bit research in constant 1987 dollars is $752,189. For the SNL labor cost, the fully burdened historical annual cost of the average scientific technical person at the Laboratories was taken for the following time periods at the following full-time equivalents (FTE):

---

[166] The argument could be made that a portion of the costs should be allocated to national security and energy since these needs are met by ensuring an energy supply. However, this study purposefully takes a conservative approach and intentionally avoids casting the national defense net too widely.

[167] GE had one contract for $312,000 allocated over a five year period.

[168] Brigham Young University, contract estimate by SNL managers.

[169] Drilling Research Laboratory, contract estimate by SNL managers.

[170] Tulsa University, estimate by former TU researcher.

Year-FTE	Year-FTE	Year-FTE	Year-FTE	Year-FTE
1974-3.5	1977-4	1980-6	1983-4	1986-4
1975-3.5	1978-4	1981-5	1984-4	
1976-3.5	1979-6	1982-4	1985-4	

using estimates made by Sandia officials. These annual labor costs were then converted to constant 1987 dollars for a total SNL labor cost of $5,795,233 (rounded).

The following equipment over $10,000 was purchased:

Year	Item	Amount	GDP Defl.	$1987
1979	drill rig	75,000	.656	114,329
1979	hydraulic test facility	50,000	.656	76,220
1985	cutter facility	12,000	.944	12,712
			Total Costs	203,261

Each item was converted to constant 1987 dollars yielding a total of $203,261 (rounded). In addition, special materials over $10,000 were purchased, including PDC cutters and PDC bits. The PDC cutters were purchased in 1978 for fabricating bits at a cost of $75,000. For research and testing purposes, 20-30 PDC bits were estimated to have been purchased in 1982 at an approximate cost of $20,000 each, for a total cost of $500,000 (25 times 20,000). Adjusted to 1987 dollars, the total cost to SNL to produce polycrystalline diamond drill bit knowledge is:

Cost Item	Amount $1987
Contracts	752,189
SNL Labor	5,795,233
Equipment	203,261
PDC Cutters	124,378
PDC Drill Bits	596,659
Total Costs	$7,471,720

The sum of these labor, equipment, and materials costs is $7,471,720.

Benefits

Benefits are measured using actual or estimated sales, actual or estimated cost savings, and government multipliers of regional impact. For this technology transfer the benefits include: PDC cutter sales, PDC drill bit sales, regional economic impact, and PDC drilling cost savings. A number of assumptions and estimations were made to calculate the benefits for this transfer. Benefits are appropriately estimated only for the period in which the conversion from one technology to the other is taking place. Once a technology becomes "best practice," the differential benefits associated with its use continue until it is replaced by another technological advance. However, since cost savings cannot be projected infinitely into the future, selection of a benefit time period seemed appropriate. The ten years from 1982 to 1992 were selected as the benefit time period for two reasons. First. 1982 represents the first year in which a "real" PDC market can be defined (see discussion in overview of technology and industry section). Second, the diffusion of the bit seems to have taken place rather completely by 1992.

PDC Cutter Sales

PDC cutters are produced by the companies that manufacture synthetic diamond. PDC cutters comprise 25% of the cost of PDC drill bits. Regrettably, there are no published data on PDC cutter sales and the markup for PDC drill bits is very proprietary. It is not possible, therefore, to obtain a reliable estimate from the information that is available (PDC drill bit sales). Therefore, although a known benefit, the benefits are understated by the amount of these sales.

PDC Drill Bit Sales

The total value of PDC drill bit sales for the 1982-92 period were obtained from three sources: for 1982 the sales were published[171], for 1983-1987 the sales were imputed using arithmetic progression, and for 1988-1992 the sales data were obtained from Sandia National Laboratories and industry sources. The sales data are shown in Table 5.The sum of the total annual sales for PDC dril [illegible] in constant 1987 dollars is then $873,131,687.

---

[171] "Diamond shear bit panel," (1982) *Oil and Gas Journal*. 80: October 4 80-82.

Table 5: Estimate of PDC Drill Bit Sales

Year	U.S. Annual Sales PDC Drill Bits	U.S. Annual Sales PDC Drill Bits(1987$)
1982	50,400,000	60,143,198
1983	56,033,333	64,258,409
1984	62,793,333	69,003,663
1985	69,553,333	73,679,378
1986	76,313,333	78,754,730
1987	83,073,333	83,073,333
1988	84,200,000	81,039,461
1989	87,500,000	80,645,161
1990	95,800,000	84,554,281
1991	116,100,000	98,724,489
1992	120,000,000	99,255,583

Regional Economic Impact

Regional economic benefits are realized with increased employment of local residents and increases in spending associated with their employment. As discussed in Chapter 2, the Regional Input-Output Modeling System (RIMS II) of the U.S. Department of Commerce's Bureau of Economic Analysis are used in this report to estimate regional economic impact[172]. In regard to correctly applying RIMS II multipliers in a retrospective study, the only multiplier requiring an adjustment for prices is the employment multiplier which is not used in this study, the output multiplier requires no adjustment[173].

The majority of PDC drill bits used in drilling in the United States are manufactured in the United States. Approximately eighty percent of these bits are manufactured in the state of Texas in the greater Houston and Dallas areas[174]. Twenty percent of these bits are manufactured in locations that are geographically dispersed in other states, making the determination of how much of the sales to use with which multipliers for the external-to-Texas twenty percent, problematic. Taking a conservative approach, the regional economic impact will be assessed for only eighty percent of PDC sales (the total benefits will therefore be understated by the regional economic impact of the remaining twenty percent of PDC sales).

---

[172] Regional Economic Analysis Division, Bureau of Economic Analysis, Department of Commerce. (1992) Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System (RIMS II). Washington DC: Government Printing Office. May.

[173] Personal interview, economic analyst with Bureau of Economic Analysis.

Based on PDC drill bit sales of $873,131,687, eighty percent of $873,131,687 is $698,505,349, the adjusted PDC drill bit sales for the regional economic impact calculation. The output multiplier for the crude petroleum and natural gas industry within the state of Texas is 1.6 (rounded)[175]. The total regional economic impact is $1,117,608,559 (1.6 times $698,505,349).

PDC drilling cost savings

Obtaining accurate figures for drilling cost savings is problematic. The drilling industry uses a straightforward equation to calculate the cost of drilling a well. The commonly known and used formula for the total dollar cost per foot drilled[176] =

$$\frac{\text{Cost of drill bit(\$)} + [\text{Rig cost (\$/hour) x Rotating time (total hrs.)}] + [\text{Rig cost (\$/hr) x trip time (total hrs.)}]}{\text{Total Footage Drilled}}$$

Bits are selected to generate the lowest cost per foot drilled, known as "minimum-cost drilling." An optimized bit selection/mix is therefore a critical element of drilling. The industry will adopt new bit technology based on the new bit's ability to reduce the cost per foot drilled[177]. As a consequence, cost-savings per foot would be the ideal way to estimate the commercial benefits of PDC bits to the drilling industry.

---

[174] Personal interviews with officials from dominant drill bit manufacturing companies.

[175] Regional Economic Analysis Division, Bureau of Economic Analysis, Department of Commerce. Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System (RIMS II). Washington D.C.: Government Printing Office. May 1992. p.121.

[176] Adams, N. (1985) "Three-step bit selection can trim drilling costs," *Oil & Gas Journal* 83: June 17 118+.

[177] In spite of their superior technical performance, PDC bits are not always economical for drilling. They are substantially more expensive than roller cone bits, and their cost must be considered against both total drilling time and rig rates. PDC bits are consequently used primarily for deep wells of suitable lithology.

The ideal approach cannot be implemented for three important reasons. First, it is not possible to know how many well feet are actually drilled with PDC bits since the morning reports prepared onsite by drilling contractors at each well that record the footage drilled by each of the several types of bits used within each well[178] are very carefully guarded proprietary information. Second, the cost savings per foot *are unique to each well*: geologic formations and highly localized drill rig costs dictate that drilling costs are truly idiosyncratic to the well being drilled. Third, the only way a company can know the actual cost savings of their bit selection is to compare the cost of drilling a new well against the cost of drilling an "offset" well[179]. The combined result of these constraints is that no national data on total PDC footage drilled or average cost savings per foot are available.

Some PDC usage patterns are known, however. One industry official explained that PDC bits are used in all "expensive" wells, e.g., offshore and deep onshore sites. If shallow wells (less than 5,000 feet) are excluded, then more than half of all oil wells are drilled with a PDC bit in some fashion[180]. Another official estimated that accounting for all types and depths of wells in the territorial U.S., about 14% are drilled with PDCs[181]. Both of these estimates are actually highly consistent: offshore drilling represents a small proportion of total wells drilled (just 2.5% in 1991), and the majority of wells drilled in the U.S. are less than 5,000 feet deep. The benefits estimated here are therefore based on the total cost savings *per well drilled with PDC bits*. Industry officials have been able to estimate the proportion of wells drilled with PDCs, and the industry has published data on the savings per well when PDCs are used.

The following assumptions are used to estimate the number of wells drilled with PDC bits each year. In the 1990s, industry estimates indicate that 14% of all wells are drilled with PDC bits. In 1982, published data indicate that 3,360 PDC bits were sold in the territorial U.S.. Assuming that only one PDC bit was used per well, 3,360 wells were drilled with

---

[178] PDC bits will be used only for the rock strata to which they are best suited and most economical. Well logs are really the only way to identify the footage drilled by each type of bit and such logs are highly proprietary.

[179] Offset wells are those for which detailed drilling records are kept, largely for benchmarking geologies, cost data, and equipment performance.

[180] Interview with officials from Amoco Production Co.

[181] Interview with drill bit manufacturer official. The estimate was obtained from data on the quantity of PDC drill bits sold (a figure that has not been publicly available since 1982), in-house knowledge about how often the bits are re-used, and the total number of wells drilled.

PDC bits, or roughly 6% of all wells drilled that year. Percentages for the intervening years were then extrapolated using simple arithmetic progression (Table 6).

Table 6: Estimated Number of Oil Wells Drilled with PDC Bits[182]

Year	Total Oil Wells	% Drilled with PDCs	Total PDC Wells
1982	57,349	5.859%	3.360
1983	50,850	6.749%	3,432
1984	59,434	7.639%	4,540
1985	49,375	8.529%	4,211
1986	26,653	9.419%	2,510
1987	24,555	10.309%	2,531
1988	22,011	11.199%	2,465
1989	19,369	12.089%	2,341
1990	22,203	12.979%	2,882
1991	21,099	13.869%	2,926
1992	17,112	14.000%	2,396

A cost savings per well (associated with the total PDC wells drilled each year) was estimated using the following considerations. The published industry reports on onshore and offshore PDC cost savings are shown in Table 7. As shown in Table 7, wells drilled from 1980-1983 show the same magnitude of benefits as those drilled from 1989-1994, there is no clear pattern of variation of benefits over time. From Table 7, in 1987 dollars, the average cost savings associated with PDC bits is $65,906 *per well*. The assumption is made here that wells with exceptional cost savings were chosen for publication. Therefore, to allow for wells that experienced less of a cost savings, the average annual benefit in 1987 dollars is assumed to be $20,000 per well.

This amount, $20,000, is an extremely conservative estimate. It is almost certain that it considerably understates the actual savings realized by at least 3¼ times, according to the

---

[182] *Source: Oil and Gas Journal Database 1994*. "Total Oil Wells" is the total number of oil and gas wells drilled in the territorial U.S., excluding dry holes. Note that the figures include a small proportion of exploratory wells, for which PDC bits are not used.

Table 7: Published Cost Savings on PDC Bits Used in the Territorial U.S. and in the Gulf of Mexico[113]

References	Year	Location	Savings per well
1. "Diamond shear bit panel," (1982) *Oil & Gas Journal*. 80: October 4 80-82.	1980	Texas	$ 50.626
1	1980	Texas	$ 71.130
2. Slack, J. and J. Wood. (1981) "Stratapax bits prove economical in Austin Chalk," *Oil and Gas Journal* 79:34 August 24 164-65+.	1980-81	Texas	$ 27.589
2	1980-81	Texas	$ 132.580
2	1980-81	Texas	$ 195.319
2	1980-81	Texas	$ 27,544
2	1980-81	Texas	$ 27.160
2	1980-81	Texas	$ 75,483
2	1980-81	Louisiana	$ 83.492
2	1980-81	Louisiana	$ 24.753
3. Andrews, T. (1983) "Shear underreamer fitted with polycrystalline diamond studs doubles penetration rate," *Oil & Gas Journal* 81: February 14 114-115.	1980-83	West Coast	$ 51,950
3	1980-83	West Coast	$ 42,546
4. Gault, A., H. Knowlton, H. Goodman, A. Bourgoyne. (1986) "PDC Applications in the Gulf of Mexico with Water-Base Drilling Fluids" *Society of Petroleum Engineers* 15614 1-12.	1986	Gulf of Mexico	$ 122,429
5. Wampler, C. and K. Myhre. (1990) "Methodology for selecting PDC bits cuts drilling costs," *Oil & Gas Journal* 88: January 15 39-44.	1989	Texas	$ 16,163
5	1989	Texas	$ 17,312
5	1989	Texas	$ 19,466
5	1989	Texas	$ 18,797
6. Boudreaux, R. and K. Massey. (1994) "Turbodrills and innovative PDC bits economically drilled hard formations," *Oil & Gas Journal* 92: March 28 52-55.	1992	Louisiana	$ 24,731
6	1992	Louisiana	$ 74,773
6	1992	Louisiana	$ 230,935
6	1992	Louisiana	$ 31,100
7. Fabian, R. (1994) "Confined compressive strength analysis can improve PDC bit selection," *Oil & Gas Journal* 92: May 16 59-6311.	1994	Rocky Mountains	$ 84,060

---

[113] Cost savings per well are adjusted to and shown in constant 1987 dollars.

non-random sample in the published savings and according to the return on investment necessary for industry to produce and use PDC bits. The greatest cost savings have been realized in international offshore wells which are not included in this sample. In addition, there is no allowance in this estimation for the use of a PDC bit in more than one well, which has and does occur. Since the data to verify greater savings is not available in public documents, the $20,000 figure is used for this estimation, knowing that the actual average cost savings per well is very likely to be notably greater.

This amount was derived by rounding off to one significant digit the lowest reported cost savings ($16,163). This flat rate of savings is assumed for each year since there is no pattern of increasing or decreasing benefits in the data. Twenty thousand represents real (as opposed to nominal) annual savings. The cost savings of PDC drill bits is thus estimated as follows:

Year	# PDC Wells	Savings per well	Annual Savings $1987
1982	3,360	$20,000	$ 80,190,931
1983	3,432	$20,000	$ 78,715,596
1984	4,540	$20,000	$ 99,780,219
1985	4,211	$20,000	$ 89,216,101
1986	2,510	$20,000	$ 51,805,985
1987	2,531	$20,000	$ 50,620,000
1988	2,465	$20,000	$ 47,449,470
1989	2,341	$20,000	$ 43,152,073
1990	2,882	$20,000	$ 50,873,786
1991	2,926	$20,000	$ 49,761,904
1992	2,396	$20,000	$ 39,636,062
Total Annual Savings			$ 681,202,133

The total drilling cost savings benefit of PDC drill bits is $681,202,133.

The sum of all of these economic benefits is:

PDC Drill Bit Sales	873,131,687
Regional Economic Impact	1,117,608,559
Drilling Cost Savings	681,202,133
Total Benefits ($1987)[184]	2,671,942,379

It is clear that all costs were incurred to produce PDC knowledge and transfer the technology from SNL. However the allocation of benefits to SNL are not as straightforward. The arguments for two different allocations and the resulting cost benefit ratios are the following.

1. **Credit 100% of the benefits to SNL**

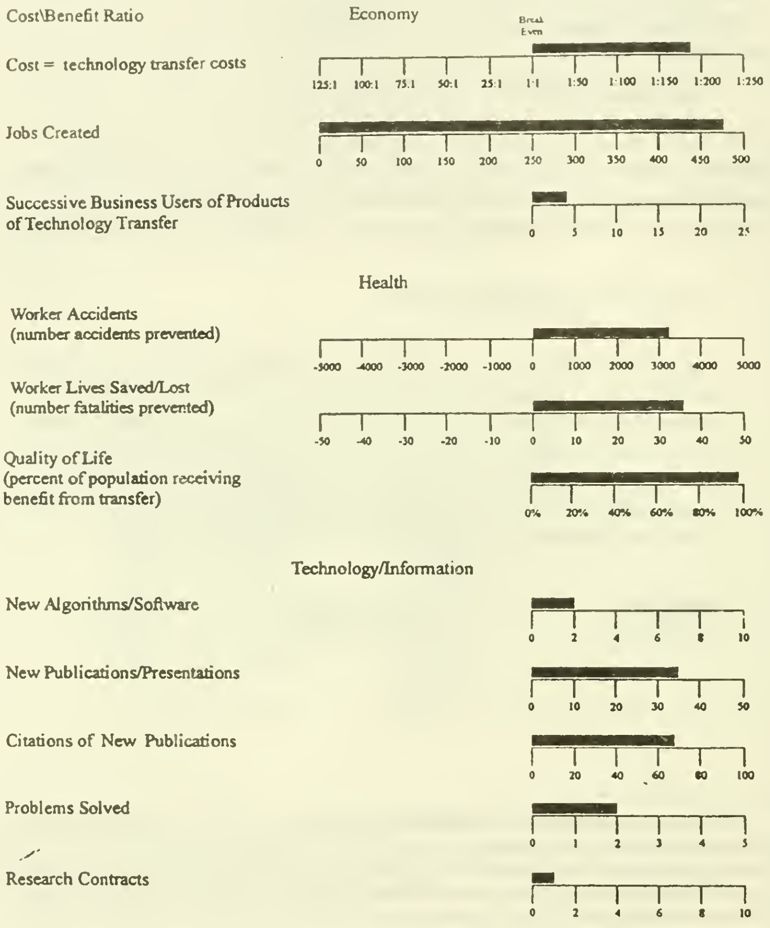
It is possible to fully credit all of the benefits to Sandia for one very simple reason: SNL's R&D has functioned as a critical precondition for innovation and market success. Stated in another way, PDC bits could not have been improved or advanced in the absence of Sandia's efforts. SNL's research findings and computer models on mechanics, hydraulics, thermal properties, force, and wear served as the foundation for commercial innovation and market acceptance throughout the PDC bit's innovation cycle. If all benefits are fully credited to Sandia, the cost-benefit ratio is:

$$\frac{\text{Total Costs}}{\text{Total Benefits}} = \frac{\$\ 7{,}471{,}720}{\$2{,}671{,}942{,}379} = \frac{1}{360}$$

---

[184] Note that these estimates are understated for the following reasons: 1) they do not include cost-savings realized by oil companies for wells drilled outside of the territorial U.S.; 2) they do not incorporate the profits realized by bringing a well on stream earlier; 3) the cost savings per well is based on averages that exclude offshore drilling, where savings are much higher than for onshore drilling; and 4) they do not include PDC cutter sales and the regional economic impact for twenty percent of PDC sales.

Figure 12: PDC Impact Profile



2. Credit 50% of the benefits to SNL

Although SNL's R&D was a critical precondition, industry still had to bring SNL's knowledge and know-how to the market[185]. In this respect, the Laboratories and industry were somewhat equal partners in the effort. This estimate allocates 50% of benefits to the Laboratories yielding:

$$\frac{\text{Total Costs}}{\text{Total Benefits}} = \frac{\$\ 7,471,720}{\$\ 1,335,971,190} = \frac{1}{180}$$

The assertion is made here that the more conservative allocation of 50% is the appropriate allocation since it more accurately represents the synergism necessary for commercialization to occur, noting that the benefits are understated by PDC cutter sales, regional impact of PDC cutter sales, and drilling cost savings from offshore drilling.

Summary

Indicators in four categories contribute to a very positive impact profile for this technology transfer. Particularly in regard to economy and technology/information, the indicators for the ten year period show that the transfer fostered productive, sustainable growth. SNL is currently engaged in research to advance the efficiency and effectiveness of PDC drill bits, further increasing the benefits that will be derived by society from this technology[186].

---

[185] The amount invested by the companies involved to commercialize the PDC drill bit and the return on that investment is not reported here because it would require information that is protected (e.g. individual company's profit structure).

[186] One recent example being the report from BP Exploration Co. (Columbia) Ltd. that in drilling in Columbia's Cusiana field, one PDC bit saved $419,000. Rappold, K. (1995) "Industry pushes use of PDC bits to speed drilling, cut costs" *Oil & Gas Journal*. August 14. 12-15.

Chapter 5: Impact Profile Evaluation

There are two key questions in this final chapter: what do the results of the plasma spray and drill bit cases imply with respect to the documentation of effects of particular technology transfers and what has been learned about impact evaluation that would be useful in extending the application of the methods employed here to different settings and circumstances? Even by a stringent standard, these two technology transfers have proved beneficial. But until a wider array of technology transfers is examined, these assessments remain isolated case studies, albeit particularly systematic ones. Thus, this section begins with a summary of the results of the two technology transfers studied and concludes with a discussion of the prospects and problems associated with extending the analytical approach developed in Phase I to other domains.

Summary of Technology Transfer Impact Profiles

Plasma Spray

The "numbers" in the plasma spray technology transfer are impressive. Depending on the way in which one chooses to calculate costs, the return on investment from the transfer is either enormous (190:1) or, at least, quite satisfactory (3:1). The impact indices do not, however, give direct insight into the factors contributing to the success of the transfer.

One important factor facilitating the transfer was an expedited security clearance received by the Fisher-Barton, Inc. employee. This enabled the transfer to occur in a timely manner. The technical competence and work culture in both SNL and Fisher-Barton, Inc. were important facilitators. Finally, the availability of the small grant from DOE was essential and foundational to the transfer. It is often the case that the infusion of a small amount of capital at the right time can produce considerable results.

The Fisher-Barton case is an excellent illustration of successful collaboration between a very large federal laboratory and a small company. Despite some inherent disadvantages, including limited capital and slack resources, small companies are, in some ways, ideal candidates for working with federal laboratories. The decentralization and flexibility of the small company often contribute, as here, to the success of collaborations. Often, a small company competes on the basis of innovation and, thus, has a vital stake in the transfer as well as great commitment. Research has demonstrated that smaller firms are more likely to develop commercial products from their interactions with federal laboratories[117].

---

[117] Ibid. Bozeman, B., et al. (1995).

Polycrystalline Diamond Drill Bit

Allocating 50% of the benefits to SNL, the yield from the polycrystalline diamond drill bit technology transfer is on the order of $180 for every dollar invested. The contribution that Sandia National Laboratories made to the oil and gas drilling industries is considerable. In many respects the PDC bit case is an ideal example of the way public R&D "should" work. The government initially got involved in PDC bits because of market failures associated with geothermal drilling technology and national priorities for energy resources. SNL management considered in its planning, the "big picture", a systems viewpoint of energy availability from discovery through production and final use of energy supplies. This led SNL to emphasize areas where industry had identifiable technical problems to be solved. Both SNL and industry could effectively work on the same problem and satisfy two very different sets of needs, serving the public good and increasing the efficiency and profitability of industry.

In collaboration with industry, the early review of the industry's technological needs, the targeting of specific technologies, and the setting of specific R&D goals provided direction uniquely available through the combination of the Laboratories' concentration and depth of scientific and engineering expertise in conjunction with the Laboratories' perspective - external to industry. The capacity to provide funds to sustain industrial R&D was also a contributing factor to this transfer's success. Technology was transferred into the public domain and widely used. Commercial benefits accrued precisely because knowledge was freely available. The collaborative spirit and free flow of knowledge are striking features of this transfer (occurring as they did in a very competitive industry).

This case stands in marked contrast to the Fisher-Barton case, not so much in the quantity of benefits as in the distribution of benefits. In the drill bit case, the benefits were distributed quite broadly and the flow of knowledge was less "hand-to-hand". While the diffuseness of the benefits presents some problems for evaluators, it is an equally valid approach to technology transfer and one that is particularly likely to lead to impacts of great magnitude.

Assessment of Impact Profile Evaluation Method: Documentation

The impact profile method appears to have some utility in documenting the results of technology transfers. Standardizing the method presents a great challenge but seems possible. This section considers the questions surrounding the validity of the approach with respect to its application to a particular transfer. The ensuing sections consider the generalizability of the results.

Generally, the impact profile evaluation method is sound for assessing costs and benefits accruing from technology transfers, based as it is on standard assumptions of a well known and widely applied set of cost-benefit analysis principles. However, the following issues need further consideration: the validity of experts' estimates, the sequence of profile preparation, the choice of indicators, the cost calculation, the boundaries of the transfer, and the economic contribution of knowledge.

In many instances, the application of the method will require the use of *experts' estimates*. The nature of retrospective analysis is such that either the type of financial and nonfinancial data needed was either not recorded in the first place, not published, or records are no longer available. If this type of assessment were to become more routine, records that would facilitate its execution might more commonly be kept as well.

For future impact profiles, the more efficient sequence of *impact profile preparation* is to first spend sufficient time up front to understand the technology and to obtain all information available from published sources. The next important step is to use this understanding and information to ensure that, if at all possible, the specific indicators for which data will be sought for the profile and appropriate scales of measurement are identified and compiled into standardized questionnaires specific to the sector (ie. a questionnaire for each type of industry involved, for SNL managers, for university scientists, etc.). If these two steps are taken prior to interviews with experts, it will improve the efficiency of the interviews.

Progress was made toward identifying what the parameters of an assessment (*choice of indicators*) of the impact of transferred technology might be. Yet, questions remain whether the four areas are comprehensive or narrow enough, whether the measures chosen within each area are appropriate and sufficient, and whether there can be any uniformity between the scales of the measures from one technology transfer to another. As was intended, the two transfers were different enough to pose singular issues in regard to the measurement of each indicator. This method can provide a point of departure for the R&D evaluation community to move toward identifying what the areas of greatest importance are, what should be measured, and what acceptable practice in measurement might be.

While there can be no simple recipe for conducting impact studies because the technologies and industries differ greatly, impact profiles provide a framework to guide future studies. It is important, as far as possible, to provide common points of comparison and to encourage that current projects be archived in ways to facilitate future research on impacts.

The great range in return-on-investment indicators is chiefly owing to different approaches to *calculating costs*. Clearly, there is no one-best-way. It is vital, however, that one be aware of the great differences depending upon cost calculation. A primary concern, in the case of technology transfer impacts, is the extent to which one "charges" as a cost the amount spent on the direct mission objectives of the laboratories. In all likelihood, the most sensible approach is to develop some type of discounted overhead investment figure to use in the calculations. This will require further research and more information about laboratories' accounting and overhead.

In a more direct, hand-to-hand transfer (e.g. Fisher-Barton, Inc.), the *setting of boundaries* is not troublesome. But in more diffuse transfers, the parsing out of credit remains a problem. It is difficult to know just where the benefit lines should be drawn. The best approach, perhaps, is just to make sure one is clear in communicating assumptions.

Each transfer examined here yielded not only tangible economic benefit but a stock of knowledge as reflected in the technology/information area. Arguably, that contribution is not fully captured by examining the economic use to which the information is put. The economic benefits are understated by the lack of quantification of the *contribution of knowledge* in dollar values. In the first place, the information may have inherent value beyond its economic use. Second, the economic appropriation of the information may occur at various points in time by various parties, including, perhaps, some in the intermediate-range and distant future. There is likely to always be an undercounting of the benefits of any scientific and technical knowledge not subject to immediate and direct appropriation.

Assessment of Impact Profile Evaluation Method: Generalization

Clearly there is little ability to generalize from two cases. What *is* required in order to generalize: how many cases, what type of approach, etc.? It is unlikely that sufficient resources will be available to perform a sufficient number of impact profile evaluations that each can be viewed as a single data point in a large sample that is an unbiased estimator of the underlying distribution of technology transfers. But this is not to say that generalization is not possible. When the sample is not large enough or structured in a way to take advantage of the laws of probability, then a good second best is a theoretically-informed sample based on an explicit model.

Thus, a first step to extending the method to a much larger domain may well be the development of a set of criteria, based on a model, for selecting transfers. For example, the model might include such factors as the size of companies, the level of resources invested, the readiness to market the focal technology, and so forth. In this way, the logic of a cross-sectional contingency design can be applied. This, in turn, permits generalization insofar as the technology transfer cases provide an adequate distribution of the sampling variables. Therefore, the question of "how many cases?" is tied directly to the model driving the analysis. A more sophisticated and detailed model will require more degrees of freedom and a larger number of cases. But, if specifications are met, the generalizability of the evaluation cases will be greatly facilitated.

Future Research

Collaborative research (consortia, partnerships, etc.) among government, university, and industry laboratories is a component of the R&D system that embodies the synergy of R&D in an institutional form. In both official and unofficial collaborative interactions, the goals and orientation unique to each sector can enhance the timeliness, creativity, and thoroughness of the research. In this study, a high degree of synergism was observed between the national laboratories, industry, and universities. The diversity represented by these elements is important to preserve and further encourage. As the national laboratories work increasingly with industry, questions of fairness and equal access become more pressing. One way to assure fairness is to foster consortia[188] that enable entire industries to benefit. In a sense the PDC drill bit transfer fits this model, although no formal consortia existed. In future studies it would be appropriate to include an early formal consortium.

Having completed Phase I, the application of a method to quantitatively demonstrate the impact of technology transferred from SNL to two technology transfers, the critical review of R&D researchers and managers will be solicited in order to improve and refine the method. The adjusted method will then be applied more broadly to a greater number and variety of technology transfers. The ultimate goal is to clearly identify the impact of technology transfer from the national laboratories in a manner that can be useful in the resource allocation process.

---

[188] An alternative viewpoint of consortia held by some researchers is that it is a good theory that only works well in rare cases for the following reasons. Positive aspects of consortia include: a broader constituency enabling a broader base of support; more productive for precompetitive research; foster breakthrough research if participants are committed and agree on licensing; more stable over time; and it is less subject to criticism of unfairness or advantage to one firm. Negative aspects of consortia include: extremely time-consuming and difficult to form because of cost, resistance due to competitiveness pressures; unwillingness to assign top researchers to work on; unwillingness to work on cutting edge technology due to competitiveness pressures; and unwillingness to make time (long term) and effort commitments. In contrast, individual companies in partnership agreements with the laboratories anticipate greater and more exclusive return and therefore commit resources more willingly and effectively.

Appendix A

The 17% of credit allocated to PDC bits for reduction of lost time accidents and fatalities was calculated as follows:

$d =$ total feet drilled per year

$t =$ total drilling manhours per year

$r =$ rate of drilling with conventional bits

$\frac{r}{2.5} =$ rate of drilling with PDC bits(assuming PDC bits drill 2-3x as fast as conventional bits and taking an average of 2.5)

Given that one third of the total feet drilled is drilled with PDC bits and two thirds of the total feet drilled are drilled with conventional bits then the total manhours drilled per year are:

$$t = \left(\frac{2}{3}\right)\left(\frac{d}{r}\right) + \left(\frac{1}{3}\right)\left(\frac{d}{r}\right)\left(\frac{1}{2.5}\right)$$

solving for r:

$$r = \left(\frac{d}{t}\right)\left(\frac{2}{3} + \left(\frac{1}{3}\right)\frac{1}{2.5}\right)$$

calculating the percent of manhours drilled with PDC bits:

$$\% = \left[\frac{\left(\frac{1}{3}\right)\left(\frac{d}{r}\right)\left(\frac{1}{2.5}\right)}{t}\right] = \left[\frac{\left(\frac{1}{3}\right)\left(\frac{1}{2.5}\right)\left(\frac{d}{\left(\frac{d}{t}\right)\left(\frac{2}{3}+\frac{1}{3}\left(\frac{1}{2.5}\right)\right)}\right)}{t}\right] = \left[\frac{\left(\frac{1}{3}\right)\left(\frac{1}{2.5}\right)\left(\frac{t}{\left(\frac{2}{3}+\frac{1}{3}\left(\frac{1}{2.5}\right)\right)}\right)}{t}\right] =$$

$$\% = \left[\frac{\left(\frac{1}{3}\right)\left(\frac{1}{2.5}\right)\left(\frac{t}{\left(\frac{2}{3}+\frac{1}{3}\left(\frac{1}{2.5}\right)\right)}\right)\left(\frac{1}{t}\right)}{t\left(\frac{1}{t}\right)}\right] = \left[\frac{\left(\frac{1}{3}\right)\left(\frac{1}{2.5}\right)\left(\frac{1}{\left(\frac{2}{3}+\frac{1}{3}\left(\frac{1}{2.5}\right)\right)}\right)}{1}\right] = \left(\frac{1}{3}\right)\left(\frac{1}{2.5}\right)\left(\frac{1}{\left(\frac{2}{3}+\frac{1}{3}\left(\frac{1}{2.5}\right)\right)}\right) =$$

$$\% = \left(\frac{1}{3}\right)\left(\frac{1}{2.5}\right)\left(\frac{1}{\left(\frac{2}{3}+\frac{1}{3}\left(\frac{1}{2.5}\right)\right)}\right) = \left(\frac{1}{(3)(2.5)\left[\frac{2}{3}+\frac{1}{3}\left(\frac{1}{2.5}\right)\right]}\right) = \left(\frac{1}{\left(2.5\left[2+1\left(\frac{1}{2.5}\right)\right]\right)}\right) = \left(\frac{1}{(2.5)(2)+1}\right) =$$

$$\% = \left(\frac{1}{5+1}\right) = \left(\frac{1}{6}\right) = 17\%$$

Dr. Ronald W. Cochran
Laboratory Executive Officer
University of California
Lawrence Livermore National Laboratory

Followup Questions and Answers

FUNDING DEPARTMENT OF ENERGY RESEARCH AND DEVELOPMENT IN A CONSTRAINED BUDGET ENVIRONMENT

QUESTIONS & ANSWERS

Hearing of the Subcommittee on Energy and Environment
Committee on Science
US House of Representatives

August 19, 1996

Ronald W. Cochran, Laboratory Executive Officer
University of California
Lawrence Livermore National Laboratory

1. *You describe your licensing agreement process. Have you conducted any professional economic analysis to see how your agreements compare with the private sector?*

Livermore's Industrial Partnering & Commercialization (IPAC) office has compared our licensing process with that used by industry, universities and other national and/or federal laboratories. In general, the Laboratory follows standard economic and financial licensing practices and uses the same techniques to license technologies. Like industry, Livermore bases its up-front licensing fees and royalty rates on estimates of many factors, including product development or commercialization time and cost, anticipated market impact, market risk, company size, exclusivity of license, etc. Although the specifics of each license or agreement are unique and individually negotiated, our licensing fees and royalty rates are, with a few exceptions for special cases, within the industry norms for R&D technologies.

We have an obligation to maximize the return on our investment for the benefit of the Laboratory and ultimately the U.S. taxpayers. Unlike industry, however, it is sometimes appropriate for the Laboratory to take into account some non-economic considerations. Other factors weigh in, such as humanitarian payoffs (e.g., for some of our healthcare technologies), direct benefits of licensing to our own R&D activities, and our general responsibility to facilitate widespread transfer of technologies we develop to U.S. industry.

2. *Under the agreements for micropower impulse radar and the high-speed cell sorter, would you say that reasonable success of the product will result in a repayment of the investments?*

   For these two very special inventions, we are optimistic about receiving payments which will meet or exceed the investments for adapting and commercializing the technologies. However, the micropower impulse radar and the high-speed cell sorter were both designed and developed within specific programs to meet the R&D mission requirements of the Laboratory. R&D costs for these specific applications were paid for by the responsible LLNL program to obtain the results and products needed to meet approved program objectives. In both of the cases cited, the success achieved in this initial R&D phase also made apparent the technology's potential commercial value. Enhancements or improvements to the product during the commercialization phase will provide benefits directly back to the Laboratory's programs, in addition to repaying investment costs.

   In the case of the micropower impulse radar, for example, discussions with various companies during the commercialization phase spawned new and different application areas for the radar technology. This in turn is leading to new designs and modifications, an expanded intellectual property base, follow-on licenses, additional royalty, etc. The resulting cycle will lead to increased royalty income for the micropower impulse radar.

   The Laboratory's principal responsibility continues to be performing R&D vital to national interests and providing long-term national benefits. However, we are very cost conscious and payback from near-term spin-off products where practical is one of our objectives. Two important factors in cost recovery are the size of the initial R&D investment and the market potential of the technology. Accordingly, even in "reasonably successful" cases, it is generally not clear whether commercialization ventures will result in repayment of all initial R&D costs.

3. *Are there barriers to putting the monies received from licensing agreements toward future cost-shared arrangements?*

   We currently have the flexibility we need to use the monies received from licensing agreements in an appropriate manner. The University of California's (UC) and Livermore's policies and procedures regarding appropriate expenditures of licensing and royalty income are clear. LLNL IPAC Policies and Procedures (Section V: Licensing and Royalty income Distribution, item D) states:

5. *In his written testimony before the Subcommittee, Deputy Inspector General (IG) Friedman referenced a May 19, 1995, IG audit report that "disclosed that efforts to manage cooperative research and development agreements at Los Alamos, Oak Ridge and Lawrence National Laboratories did not fully achieve the Department's policy goals." What, if any, actions has Lawrence Livermore National Laboratory taken to address the finds of that IG report?*

The audit was based on survey work conducted between October 1993 and June 1994. At that time we were on a steep learning curve in dealing with CRADAs, and a lot has happened since then. Upon receipt of the IG audit report, we studied it and provided formal comments on it to DOE Oakland Operations Office. We noted that many of the improvements suggested within the report recommendations were already in progress aided by existing CRADA implementation guidance. These improvements and others we have made since have addressed the principal concerns raised.

As I discussed in my written testimony, we have clearly defined procedures and responsibilities within our Laboratory for managing CRADA efforts from project selection through to the final reports and customer surveys. The management system is much improved compared to that which was in place at the time of the audit. We have a very strong focus on ensuring that Laboratory R&D programs derive tangible benefits from CRADAs. This means clearly defined goals, milestones, and schedules for both the Laboratory and our partners. In addition, we have program-review and reporting mechanisms in place to examine the technical aspects of projects and to compare planned and actual costing and performance to planned milestones for both parties. As I also noted in my written testimony, final reports are prepared jointly by the partnership team. Additionally, we conduct a customer survey to find out how well Livermore met our partner's expectations during the technical execution of the CRADA.

Dr. Charles F. Gay
Director
National Renewable Energy Laboratory
Golden, Colorado

Followup Questions and Answers

HEARING OF THE SUBCOMMITTEE ON ENERGY AND ENVIRONMENT
COMMITTEE ON SCIENCE
U.S. HOUSE OF REPRESENTATIVES

on

Funding Department of Energy Research and Development In a Constrained Budget Environment

Responses to Follow-up Questions Submitted to

Dr. Charles F. Gay
Director
National Renewable Energy Laboratory (NREL)

August 19, 1996

1. What types of licensing and patenting agreements is NREL involved in, and what policies does the Lab have for such agreements?

NREL utilizes a wide range of licensing agreements. Licenses can be exclusive or non-exclusive; the Lab generally favors non-exclusive licenses in order to maximize private sector access to NREL advances and to foster private sector competition. Licenses generally contain limitations on the field of use in order to better facilitate simultaneous applications of NREL technologies in divergent fields, thereby increasing private sector access to these technologies, and to provide multiple licensing revenue opportunities for the Lab. Licenses contain geographic limitations and/or time limitations where appropriate. Licenses generally are royalty bearing and may also require an up-front payment.

NREL's existing license agreements are distributed roughly equally between exclusive and non-exclusive agreements; several of the exclusive licenses are with CRADA partners who participated in a substantive way in developing the technology licensed. A typical NREL technology license contains royalty payment requirements, generally based on the licensee's sales of products incorporating the licensed technology. About a third of the active license agreements included a modest up-front payment (e.g. $5,000 - 20,000), intended primarily to dissuade potential licensees that lack the resources and/or the commitment to commercialize the licensed technology. Based upon current assumptions, it is reasonable to conclude that royalty-bearing NREL licenses can generate upwards of $0.5 million per year over the next 5-10 years, which (consistent with applicable law and Midwest Research Institute's Prime Contract with the Department of Energy) could be another source of funds for advanced research projects not otherwise being supported by DOE.

NREL utilizes a variety of patenting agreements with its research partners. Cooperative Research and Development Agreements (CRADA's) typically reserve patent rights ownership to the inventing party or parties. It is not uncommon for inventorship to be shared by NREL personnel and CRADA partner personnel. In addition, the CRADA private sector partner generally is given first rights to license and commercialize intellectual property invented by NREL staff during the joint research of a CRADA.

NREL policies regarding patents and patent licenses are largely defined by the Lab's Prime Contract with DOE and applicable laws on CRADAs and licenses. NREL's practices in applying these policies focus on four prime criteria:

1. Use licenses to accelerate the commercialization of renewable energy technologies so as to return value to the taxpayers through private sector commercialization and public sector royalty revenue.

2. Comply with Fairness of Opportunity Requirements.

3. Give preference to U.S. industry.

4. Conduct technology transfer activities with the purpose of leveraging Federal research for U.S. industrial competitiveness.

NREL has been successful in securing strong patent positions in key renewable energy technologies and in licensing these technologies to the private sector. The Lab is now moving to better solidify its intellectual property management in order to maximize the impact of NREL technology advances on the development of the U.S. renewable energy industry and to enhance the Lab's revenue earnings from its intellectual property.

2. How does NREL "market" its patents?

NREL is active in "marketing" its intellectual property through a variety of channels. The major efforts are in two areas: broad outreach and targeted offers.

NREL's broad outreach efforts to market its intellectual property are aimed at communicating to a wide and diverse audience the availability of innovative intellectual property and the Lab's interest in licensing that property. Examples of such broad outreach efforts include:

> **Trade journal articles and advertisements**: We advertise in trade journals and aggressively pursue publication of our technology advances in both the scientific journal literature (e.g. Progress in Photovoltaics), the broad trade journal literature (e.g. Research Magazine) and the popular press (e.g. Popular Mechanics).

Conferences and Trade Shows: We hold "Industry Open House" meetings where we showcase key NREL technologies to a select set of invited industry representatives. We participate in trade shows and conferences such as The GM Forum, Soltech, Utility PhotoVoltaics Group meetings, the upcoming Technology 2006 technology trade show, etc.

Commerce Business Daily (CBD): New technologies available for licensing are announced in the CBD. Also, when a request for an exclusive license is made we always advertise this fact in the CBD to fulfill "fairness of opportunity" requirements and to solicit potential additional interest.

NREL Internet - Home Page: We maintain the list of the technologies available to potential licensees on the NREL internet-home page. We plan to upgrade our Internet accessibility by introducing an easy-to-use "addressable" table of contents to ease access to intellectual property and licensing opportunities and by adding links to venture firms and trade groups (e.g. Solar Energy Industries Association).

NREL's "targeted offers" efforts to market its intellectual property are aimed at contacting specific interested parties that the Lab believes are likely to license specific technologies. Examples of such targeted offers include:

Targeted Contacts: As NREL technologies become available for licensing, we frequently target a group of key players (e.g. private sector groups with related and/or complementary technology positions) and initiate discussions of their licensing NREL technologies. This approach has been very successful with advanced air foil technologies for high-performance wind turbines and with thin-film CIGS materials and device designs for low-cost photovoltaics.

We plan to expand this targeted contacts effort by using business data bases (e.g. CORPTEC, TELTEC, etc.) and in-depth market research (e.g. KPMG) to identify industry contacts to be invited to the Lab to discuss licensing opportunities for specific NREL technologies.

NREL Subcontractors and/or Allied Businesses: We frequently get requests about licensing specific technologies from our R&D partners (of which we currently have about 300), or their allied businesses working in related areas.

Enterprise Growth Forums: NREL organizes Enterprise Growth Forums at which growth-stage renewable energy companies discuss their business plans and needs. The primary goal of the Forum is to build stronger working relationships between the renewable energy industry and the investment community. A secondary goal of the Forum is to showcase technologies that NREL has originated and/or supported through its industry research partners. This exposure can result in enhanced licensing revenue flow to the Lab and/or follow-on technology licensing opportunities for the Lab. We have held five of these forums over the last year.

Other Avenues to Market NREL Technologies: We respond promptly to unsolicited calls from investors and/or their representatives.

This combination of broad outreach and targeted offers has proved effective at securing licensing agreements that move NREL technology into the private sector and return license revenue to the Lab.

BOSTON PUBLIC LIBRARY
3 9999 05984 276 3

ISBN 0-16-054948-5
90000
9 780160 549489